Reserved.] Telegraphic Address: "Ageekay, London." A B C Code. [Registered at G.P.O. as a Newspaper

VOL. XXVII.]
No. 678.]

NOVEMBER 21, 1890.

[PRICE
FOURPENCE.

DEC 1 1890

THE ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—SUBSCRIPTION per annum, Postage inclusive, in Great Britain, 19s. 6d.; to Countries in Postal Union, of the first class, 21s. 8d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—NEW YORK: D. VAN NOSTRAND, 23, Murray Street, and 27, Warren Street. PARIS: Madame VEUVE J. BOYVEAU, Librairie Etrangère, 22, Rue de la Banque. BERLIN: A. ASHER & Co., 5, Unter den Linden.

FOR CONTINUOUS OR ALTERNATING CURRENTS.

BROCKIE-PELL ARC LAMP

ABSOLUTELY STEADY AND RELIABLE.

BROCKIE-PELL ARC LAMP

IN SERIES OR PARALLEL.

BROCKIE-PELL ARC LAMP

OUTDOORS OR INDOORS.

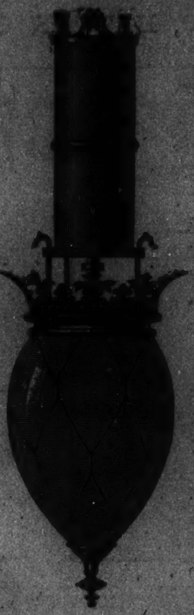
BROCKIE-PELL ARC LAMP

SINGLE CARBON DOUBLE CARBON.

BROCKIE-PELL ARC LAMP

16 HOURS 32 HOURS.

BROCKIE-PELL ARC LAMP



EXTREMELY SIMPLE. GIVES NO TROUBLE.

BROCKIE-PELL ARC LAMP

NEW ILLUSTRATED CATALOGUE NOW READY.

Sole Makers:

JOHNSON & PHILLIPS,

ENGINEERS AND ELECTRICIANS,

14, UNION COURT, OLD BROAD STREET, LONDON, E.C.

Works and Wharf: CHARLTON, KENT.

TELEPHONE No. 1010. Telegrams: "JUNO, LONDON." A B C CODE, 4th Edition. 213

VULCANIZED INDIA-RUBBER

CABLES AND WIRES

OF EVERY DESCRIPTION.

BEST QUALITY AND VALUE. PROMPT DELIVERY.

SPECIAL CONCENTRIC CABLES

FOR TOWN LIGHTING.

SILVER MEDAL, INTERNATIONAL ELECTRIC EXHIBITION, 1882.

International Inventions Exhibition, 1885, GOLD MEDAL for Machinery, SILVER MEDAL for Cables and Wire.

WALTER T. GLOVER & CO.,

Electrical Wire and Cable Makers,

TELEGRAM ADDRESSES: "WALTER GLOVER," SALFORD. "PHONOSCOPE" LONDON.

SALFORD, MANCHESTER.

ESTABLISHED 1868.

WORKS:—
Bridgewater Street Iron Works.
Salford Electric Wire Works.
Springfield Cable Works.
SALFORD.

LONDON: 10, HATTON GARDEN, E.C.

CROGGON & CO.,

LIMITED,

16, UPPER THAMES ST., LONDON E.C.,
19, Tithebarn Street, LIVERPOOL.
7, John Street, GLASGOW.

ELECTRICAL ENGINEERS & CONTRACTORS,

MANUFACTURERS OF

ELECTRIC LIGHT FITTINGS,

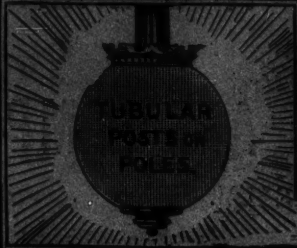
Bells, Indicators,

LIGHTNING CONDUCTORS,

AND

SPEAKING TUBE FITTINGS.

SEND FOR ILLUSTRATED LIST, POST FREE.



TUBES

WROT IRON OR STEEL

GAS, STEAM, WATER, BOILER TUBES, AND FITTINGS.

for "ELECTRICAL CONDUCTORS." PLAIN OR GALVANIZED

JOSEPH AIRD,

TUBE-WORKS. GREAT-BRIDGE, STAFFORDSHIRE.

LONDON OFFICE: 46, QUEEN VICTORIA ST E.C.

W. H. WILLCOX & Co.,

Oil Refiners,

36, SOUTHWARK STREET,
LONDON.
Works:—EWER STREET,
TELEPHONE No. 4740.

ONLY OIL used last three years by the largest Electric Installations in London. Samples sent on application.

SUCCESS GUARANTEED. TRIAL SOLICITED.

Price 2s. 9d. per Gallon.

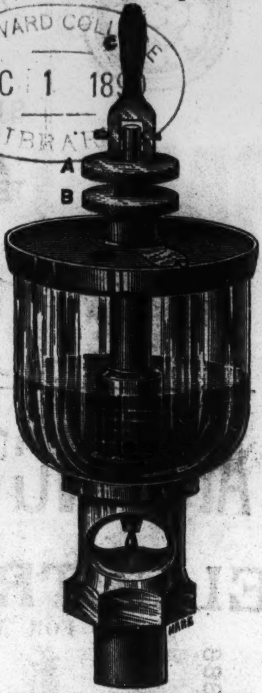
Our Oil is now recommended by the principal Electricians, and is also suitable for

SHAFTING, ENGINES,

AND GENERAL PURPOSES. 2927

PATENT
OIL CUP
With Visible Drop Feed.

HARVARD COLLEGE
DEC 1 189
LIBRARY



For use on Dynamos and High-Speed Engines.

THE UNITED ASBESTOS Co., LIMITED.

PIONEERS OF THE ASBESTOS TRADE.

The ONLY COMPANY in the World owning and working Asbestos Mines in both ITALY and CANADA. 3647

- FINE ASBESTOS PAPER, for Dynamos, &c.
- ASBESTOS TUBES & CEMENT, for Electric Light Leads.
- ASBESTOS FIRE-PROOF PAINT, for protecting woodwork, troughs for leads, &c.
- ASBESTOS MILLBOARD STRIPS, for ditto.
- FINE ASBESTOS THREAD, for covering wires.
- ASBESTOS COVERED WIRES.
- PATENT SALAMANDER LUBRICANT, for Dynamos, &c.
- PACKING, NON-CONDUCTING COVERING for Boilers, &c.

DOCK HOUSE, **BILLITER ST.,**
LONDON, E.C.
(*Late 161, Queen Victoria Street.*)

All Goods are made at our Works, near London, and are of the best possible description.

Specify "SALAMANDER" Brand.

Depôts: NEWCASTLE-ON-TYNE, Quay Side; MANCHESTER, 34, Deansgate; LIVERPOOL, 47 and 49, South John Street; GLASGOW, 60, West Howard Street; CARDIFF, Mount Stuart Square; BRISTOL, Provident Buildings, Clare Street; ST. PETERSBURG, Gostinoe Dvor.

FREDERICK SMITH & CO.,

CALEDONIA WORKS, HALIFAX.

Contractors to Her Majesty's Government & Railway Companies

BEST REFINED TELEPHONE WIRE.

PATENT GALVANISED TELEGRAPH WIRE.

100 lb. COILS, HIGH CONDUCTIVITY.

SPECIALITY:—TELEGRAPH WIRE, TO ALL SPECIFICATIONS.

COPPER WIRE, hard drawn, high conductivity—long lengths. COPPER WIRE and TAPE for Lightning Conductors, &c. COPPER WIRE, all sizes for covering. STRAND WIRE all kinds. GALVANISED HARD STEEL STRAND for Mechanical Telephones. 1354

F. WIGGINS & SONS, 10, TOWER HILL, E., and 102, MINORIES, E.C. **LONDON,**
MICA MERCHANTS, [*Telephone No. 2248.*
Manufacturers of Mica Goods for Philosophical and ALL purposes.
CONTRACTORS TO HER MAJESTY'S GOVERNMENT. 2831

MICA.

PATENT OFFICE.

H. GARDNER,

166, FLEET STREET,
LONDON.

SUCCESSOR TO
Messrs. ROBERTSON, BROOMAN & CO.

PAMPHLET OF COSTS GRATIS.

FORTY-TWO YEARS' SPECIAL PRACTICE WITH INVENTIONS. 4012

Wm. M. FOXCROFT

(*Successor to the late W. Foxcroft, also F. Lucas*),

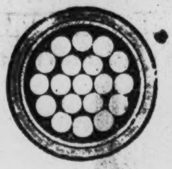
Telegraph and Telephone Case Manufacturer,

36, PERCIVAL STREET AND 9, SMITH STREET,
CLERKENWELL, LONDON, E.C.
(Offices—PERCIVAL STREET).

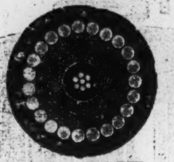
Lock and Block, Single Needle, Bell, Sounder, Perforator, Photometer, Telephone Cases, Battery Boxes, &c., &c.

PRIZE MEDALS, LONDON, 1851; PARIS, 1881. 261

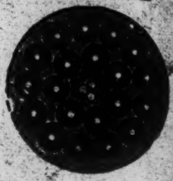
ELECTRIC LIGHT.



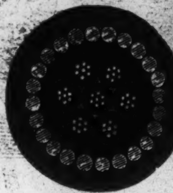
TELEGRAPH.



TELEPHONE



TORPEDO.



W. T. HENLEY'S TELEGRAPH WORKS
COMPANY, LIMITED.
Offices:—27, Martin's Lane, Cannon Street, London E.C.
Telephone No. 1,734. Works:—North Woolwich.

Manufacturers of
SUBMARINE CABLES,
Patent Metallic Braiding,
TELEPHONE CABLES.

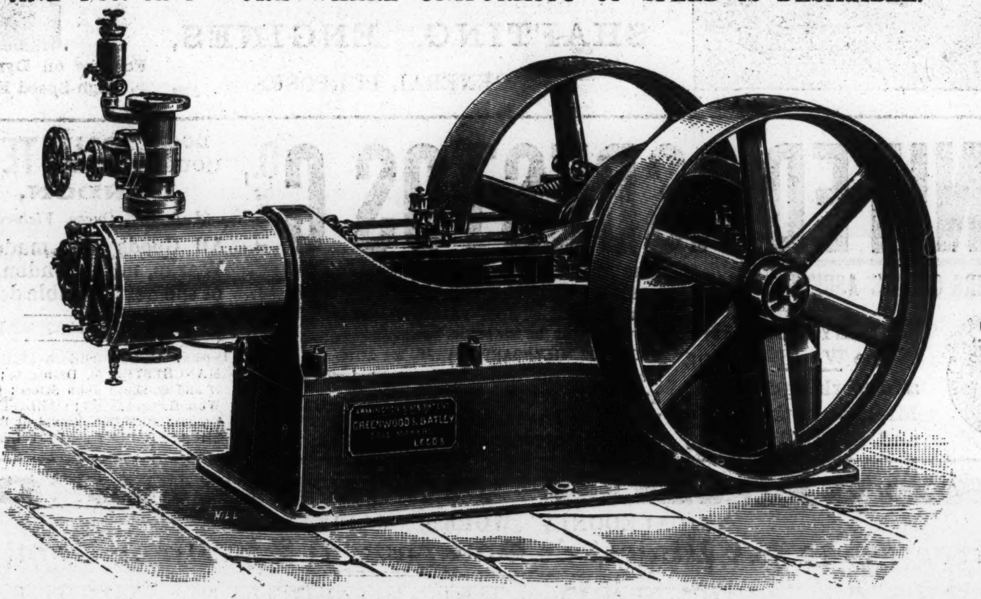
GUTTA-PERCHA,
VULCANISED INDIA-RUBBER.

DYNAMO WIRE
Silk Covered Wire,
FLEXIBLE CORDS,
AND
ELECTRIC LIGHT CABLES.
202

ARMINGTON-SIMS PATENT ENGINE,
SPECIALLY ADAPTED FOR
ELECTRIC LIGHT INSTALLATIONS
AND FOR ANY WORK WHERE UNIFORMITY OF SPEED IS DESIRABLE.

GOLD MEDALS:
EDINBURGH, 1886; LIVERPOOL, 1886.

GOLD MEDAL
Awarded at the International Inventions Exhibition
South Kensington, 1885.



SOLE MAKERS:
GREENWOOD & BATLEY, LTD., ALBION WORKS, LEEDS.
PRICES ON APPLICATION.
1706

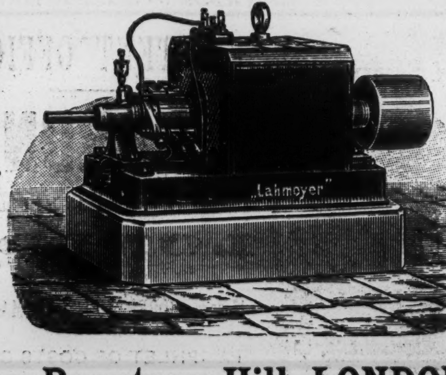
"THE MOST EFFICIENT"
AND CHEAPEST
DYNAMO
IN THE MARKET.

Our Continuous Current Patent "Lahmeyer" Dynamo cannot be excelled for perfect working and actual cost; should be seen to be appreciated.

We also manufacture a special machine for coupling direct to motor.

3513 CATALOGUE FREE.

BOLLING & LOWE, 2, Laurence Pountney Hill, LONDON.



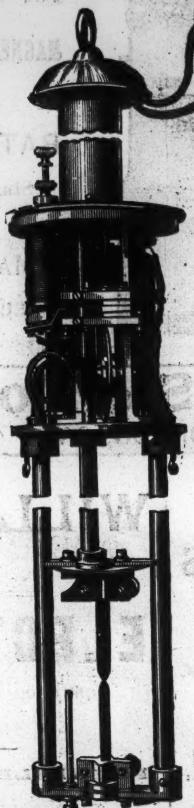
THE PLANET ELECTRICAL ENGINEERING Co., LTD.
4, VICTORIA MANSIONS, WESTMINSTER.

PLANET ARC LAMP

The only Reliable Motor Lamp in the market for Street Lighting, Ships and interior of premises

Positive Feed. Can be burnt in any position. All Engineers connected with Central Stations should see this Lamp.

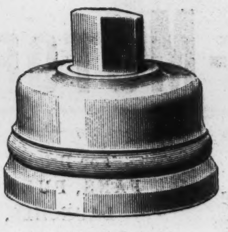
FOR DIRECT OR ALTERNATING CURRENTS.



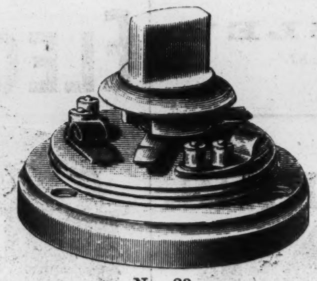
Prof. SILVANUS THOMPSON says:—"This is the Electrical Engineer's Lamp."

THE
ELECTRICAL ACCESSORIES Co.,
LIMITED,
66, VICTORIA STREET, LONDON, S.W.
Works:—BIRMINGHAM.

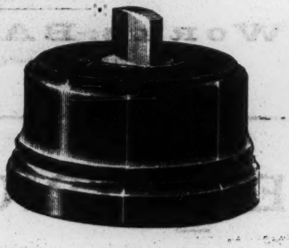
SWITCHES.



No. 110.
3-AMPERE, NO FUSE.



No. 23.
4-AMPERE, WITH FUSE.



No. 117.
12-AMPERE, WITH FUSE.

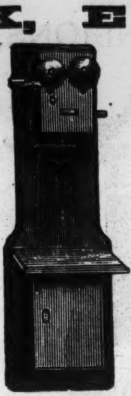
INSTANTANEOUS BREAK.
BRIDGE CONTACT.
DOUBLE BREAK.

These Switches are made in White China, or Black with White Thumb-pieces.

EASILY WIRED.
LONG FUSES.
NO FAILING PARTS.

BLAKEY, EMMOTT & CO., LTD.,
HALIFAX, ENGLAND.

SOLE MANUFACTURERS UNDER LICENCE
OF
FLETCHER'S WATCHMAN'S TELL-TALE
(As largely used by the L. & N. W. Railway and other Companies),
THE BLAKEY-EMMOTT DYNAMO.
WARBURTON AND CROSSLEY'S RELAY.
EDMONDSON'S CALCULATING MACHINE,
Silver Medal, Inventions Exhibition.



MANUFACTURERS OF
MAGNETO BELLS, SWITCH BOARDS, SWITCHES,
ANNUNCIATORS, &c.,
BATTERIES OF ALL KINDS.
Single Needle, Block and Morse Instruments,
INSULATED WIRE,
SEMAPHORE AND LIGHT REPEATERS.
ELECTRIC BELLS AND INDICATORS. 521

J. D. F. ANDREWS & Co.,
41 & 42, PARLIAMENT STREET, LONDON, S.W.
Complete System of Concentric Wiring for Interiors. Andrews's Patent Joints, Switches, Fuses and Fittings. Lists and Trade Terms on application.
Concentric Wire Rules Free on Application.

EXCELSIOR
ELECTRO-PLATING DYNAMOS
For Nickel and Silver Plating, Brassing, Electro-typing, &c., as used by all the principal Platers in London.
PRICES FROM £6. Numerous Testimonials.
VATS, ANODES, AND COMPLETE OUTFITS.
CARL OPPERMANN, 2, Wynatt St., Clerkenwell.
3764

ARTHUR B. GILL & Co.,
Electric Light and General Engineers,
4, BOMBAY STREET, BERMONDSEY, LONDON, S.E.

Sole Makers of GILL'S PATENT MAIN SWITCHES, which are practically everlasting. No sparking on the actual contact pieces. These switches improve with using. Makers of the "GILL" DYNAMO AND MOTOR, which are unequalled for cheapness and efficiency. SUPPLIERS OF ALL ELECTRICAL REQUISITES. LIBERAL TRADE TERMS.
Telephone No. 4832. *Telegraphic Address:* "*TORQUE.*" 2949

CARBONS.
H. & F. CHAMBERLAIN,
Manufacturers of Pure Carbon Points, Tubes, Filters, Cells and Battery Plates of every description.
WORKS:-BARNSLEY.
Telegraphic Address:—"CARBON BARNSLEY." 3398

ELECTRIC WIRES.
Insulated Wire and Cables of every description for Electrical Instruments, Dynamo Machines, Electric Bells, Telephones, Electric Lighting, &c., &c.

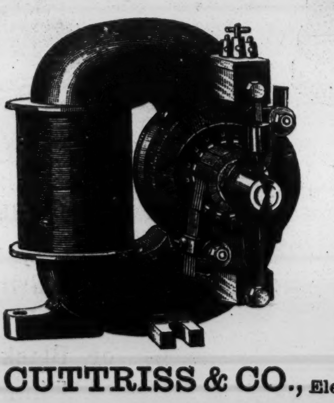
UNITED ELECTRIC WIRE Co.,
14a, Clerkenwell Green. London, E.C. 1730

WILLIAM RICKARD,
DERBY.
ELECTRICAL WIRES
Insulated with Silk, Cotton, India-Rubber, Gutta-Percha, &c., &c.
FLEXIBLE CORDS A SPECIALITY.
3529

THOMAS BARRACLOUGH & CO., Ltd.,
Makers of all the most Improved Machinery for Electric Wire and Strand Covering, Lapping, Taping, Braiding, &c.,
ALSO FOR
STRANDING AND MAKING CABLES OF EVERY SIZE AND DESCRIPTION.
Globe Works, Rochdale Road, Manchester. 1960

H. THORPE,
MAKER OF EVERY CLASS OF
Screw, Terminal and Turned Parts,
Also any Description of
ELECTRICAL OR MECHANICAL AUTOMATIC MACHINES.
SOLE MANUFACTURER OF THE ENGLISH REMINGTON TYPE WRITER.
All High-Class Machine Work, Turning, Boring, Screw Cutting, &c.
Wheels Cut to 12-inch die in Iron, Steel, or Brass.
OPEN TO TAKE AGENCY FOR ANY MECHANICAL OR ELECTRIC MAGHINE.
Works: 34, Eagle St., Red Lion Square.

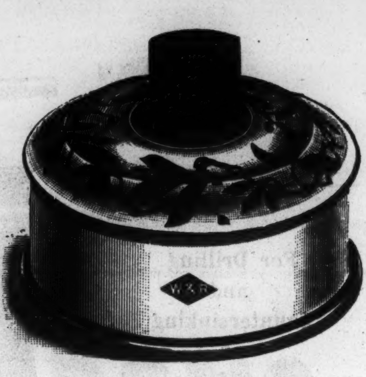
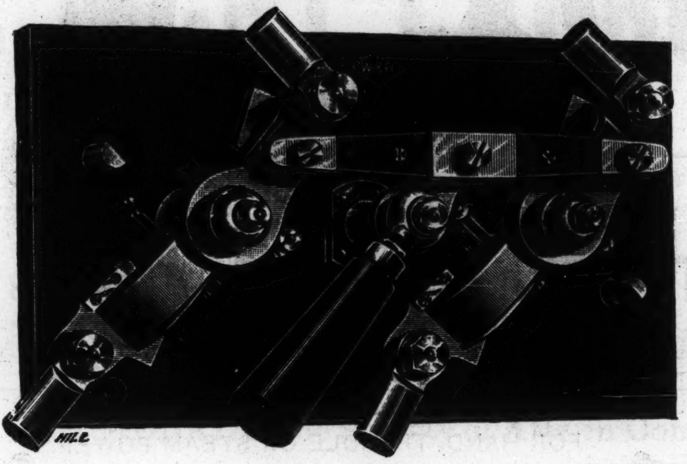
ELECTRO-MOTORS

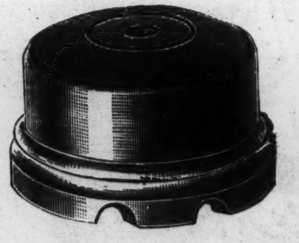


From $\frac{1}{50}$ to 50 H.P.
For Driving
FANS, PUMPS,
LAUNCHES,
ROCK DRILLS,
PRINTING PRESSES,
and
GENERAL MACHINERY.
COMPLETE PLANT FOR THE TRANSMISSION OF POWER.
Enlarged Illustrated Catalogue now ready.
CUTTRISS & CO., Elmwood Electrical Works, Leeds.

SWITCHES, CUT-OUTS, CEILING ROSES, &c.

PORCELAIN OR SLATE. **FANCY OR PLAIN.**



WRITE FOR PRICES.

WOODHOUSE & RAWSON UNITED, LIMITED,

LONDON, MANCHESTER, BRADFORD & KIDSGROVE.

Telegrams: "WOODHOUSELONDON." **Telephone No. 1978.**

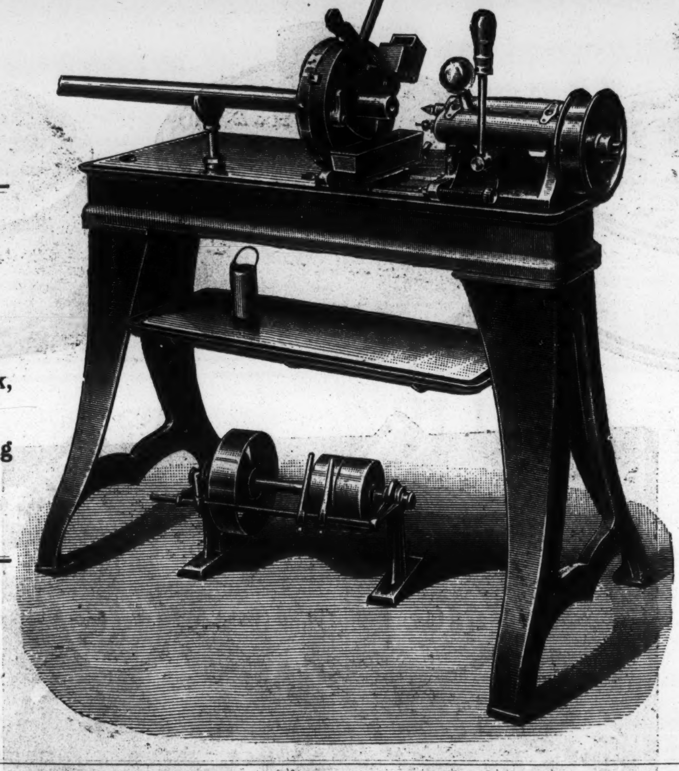
2967

SELIG, SONNENTHAL & Co.,

SOLE LICENSEES OF THE

PATENT TWO-SPINDLE CENTREING MACHINE.

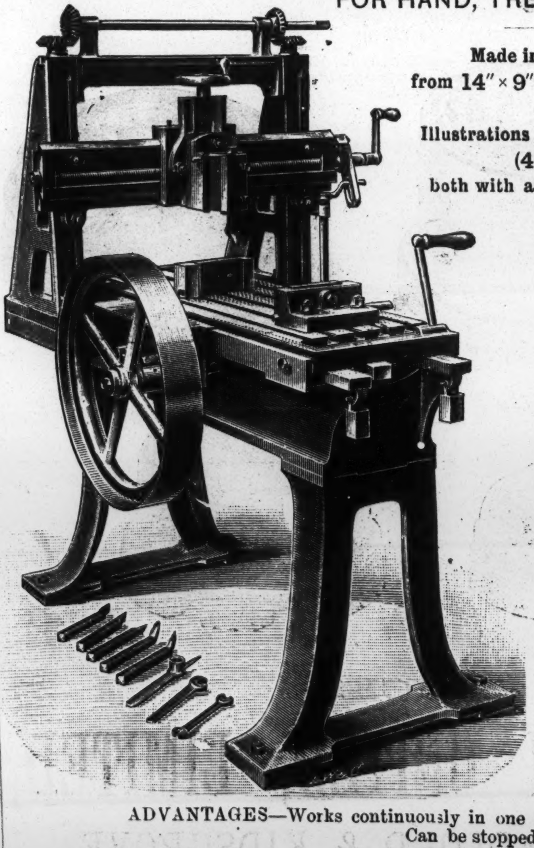
For Drilling
and
Countersinking
at
one setting of the work,
with stops to
prevent countersinking
too deep.



For Shafts
from 1/8" to 3¾" diameter.
Weight
about 3¾ cwts.

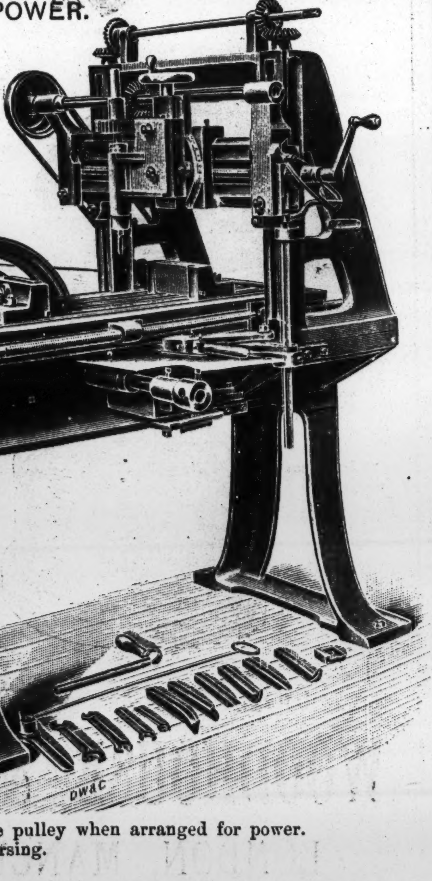
Patent "EUREKA" Planing Machine

FOR HAND, TREADLE OR STEAM POWER.



Made in Five Sizes, to plane
from 14" × 9" × 14" to 60" × 32" × 20"

Illustrations represent the Fourth Size
(40" × 24" × 16"),
both with and without Slot Drilling
Attachment.



ADVANTAGES—Works continuously in one direction. Works with one pulley when arranged for power.
Can be stopped instantly, even whilst reversing.

IN STOCK READY for IMMEDIATE DELIVERY.

A large assortment of Lathes, Radial and Pillar Drilling Machines, Milling, Planing and other Machine Tools. 4033

85, Queen Victoria Street, & Lambeth Hill, LONDON.

JOHN WHITE & SONS,

TANNERS, CURRIERS & LEATHER MERCHANTS.

WORKS:
PARK ROAD, LEATHER WORKS,
BINGLEY, YORKSHIRE.

AWARDS.
Leeds - - 1873.
Paris - - 1878.
Bradford - 1882.
Amsterdam, 1883.
Huddersfield - - - - 1883.
International Inventions, 1885.
Colonial and Indian - - 1886.
Saltaire - - - - - - - 1887.

Registered
Telegraphic Address:
"WHITESONS, BINGLEY."

SELECTED BY THE EXECUTIVE COUNCIL TO SUPPLY THE LEATHER BELTING FOR THE MACHINERY IN THE ELECTRIC LIGHT DEPARTMENT OF THE INVENTIONS EXHIBITION, 1885, AND AGAIN IN THE SAME DEPARTMENT FOR THE COLONIAL & INDIAN EXHIBITION, 1886.

PATENT V OR TRIANGULAR AND SQUARE LEATHER ROPES.

SPECIALITIES FOR ELECTRIC MACHINERY.

The following particulars relating to a portion of the Main Belts for Driving the Machinery in the Electric Light Department of the International Inventions Exhibition of 1885 and the Colonial and Indian Exhibition of 1886, may be of Interest, showing such combined results in Belt Driving as have probably never been previously attained :—

	Length	Width	Speed	Transmitted
No. 1	70 feet	× 10 inches	2,585 feet per minute	120 I.H.P.
No. 2	73 feet	× 15 inches	2,585 feet „	170 „
No. 3	60 feet	× 16 inches	3,270 feet „	200 „
No. 4	86 feet	× 24 inches	2,585 feet per minute	350 I.H.P.
No. 5	86 feet	× 15 inches	2,585 feet „	170 „
No. 6	86 feet	× 15 inches	2,585 feet „	170 „
TOTAL				1,180 I.H.P.

JOHN WHITE & SONS supplied the Main Driving Belts at the Bradford Technical School Exhibition, 1833; the Huddersfield Technical School Exhibition, 1833; and the Saltaire Exhibition, 1887; being awarded GOLD MEDALS ON ALL THE OCCASIONS for complete efficiency.

4081

MAHLA'S

ARC LIGHT CARBONS

ACKNOWLEDGED BY USERS

SUPERIOR TO ALL OTHERS.

LARGE STOCK IN LONDON. PRICES AND SAMPLES FROM

THE SOLE AGENTS:—CATHCART AND PETO,

57B, HATTON GARDEN, E.C., and VULCAN WORKS, ISLINGTON, N., LONDON.

3930

Awarded the GOLD MEDAL of the Society of Arts, in Competition, 1889.

THE "GRIFFIN" DOUBLE ACTING GAS ENGINE.

UNEQUALLED FOR DRIVING ELECTRIC LIGHT MACHINERY.

Sizes from 1 to 150 Indicated Horse Power in ONE Cylinder only. Also SPECIAL DOUBLE Cylinder Type up to 300 Horse-Power.

SIMPLE,

RELIABLE,

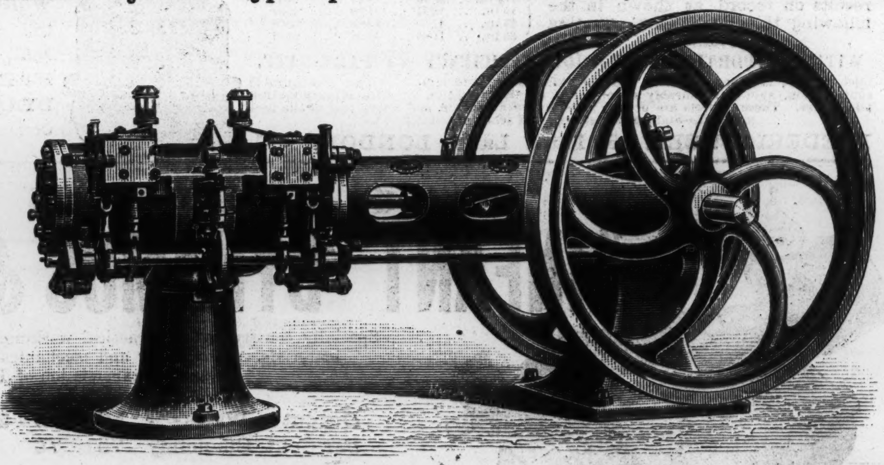
ECONOMICAL.

NUMEROUS HIGH CLASS TESTIMONIALS.

Full Guarantee given with every Engine.

WORK EQUALLY WELL WITH

COAL, OIL, OR WATER GAS.



SOLE MAKERS:

DICK KERR & CO., Limited, London, Bristol, and Glasgow.

LONDON SHOWROOM:—76, Queen Victoria Street, E.C.

Works:—KILMARNOCK.

3939

BEST WIRE

FOR

OVERHEAD TELEPHONE & TELEGRAPH LINES,

And all Electrical Purposes.

SILICIUM BRONZE.

PHOSPHOR BRONZE.

PHOSPHOR BRONZE CASTINGS, &c.

Patent Phosphor Bronze for Springs, Ropes, Screws, Rods, Sheets, &c., Bearings, Bushes, and other wearing parts of Machinery

Patent Silicium Bronze and Silicium Copper Wire of Great Tensile Strength and High Conductivity for Telephone and Telegraph Lines & other Electrical purposes.

PHOSPHOR BRONZE
VULCAN
PHOSPHOR
DURO METAL

SOLE PROPRIETORS
Of the British and Colonial Patents,
THE PHOSPHOR BRONZE CO.,
LIMITED,
87, Sumner Street, Southwark, London, S.E.

BEWARE OF SPURIOUS IMITATIONS, FALSE REPRESENTATIONS, AND INFRINGEMENTS OF OUR PATENT RIGHTS.

THE ACME ELECTRIC WORKS

Telephone No. 7629.] (FRANCIS TEAGUE, *Manager*), [*Telegrams: "Sounder, London."*

Head Office & Showrooms: 17, PRINCES STREET, HANOVER SQUARE. Factory: FERDINAND STREET, CHALK FARM, N.W.

ELECTRIC AND TELEGRAPHIC ENGINEERS AND CONTRACTORS TO H.M. WAR OFFICE, ADMIRALTY, G.P.O., LONDON COUNTY COUNCIL, &c.

MANUFACTURERS OF COCKBURN PATENT LOCK AND QUICK BREAK SWITCHES. 4004

Main Switchboards, Cockburn Patent Cut Outs and Fuses, Electrical Accessories.

THE VICTOR TURBINE

Possesses more than Double the Capacity of other Water Wheels of same diameter, and has produced the best results on record, as shown in the following tests at Holyoke Testing Flume.

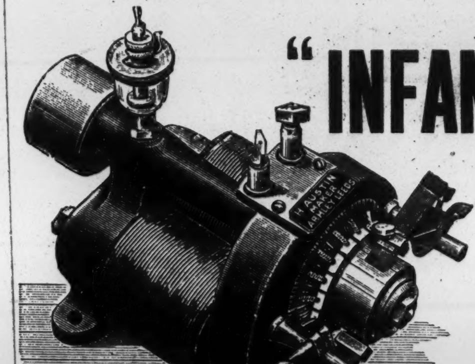
Size wheel.	Hd. in ft.	H.P.	Per cent. useful effect.
15 in.	18·06	30·17	·8932
17½ in.	17·96	36·35	·8930
20 in.	18·21	49·00	·8532
25 in.	17·90	68·62	·8584
30 in.	11·65	52·54	·8676

WITH PROPORTIONATELY HIGH EFFICIENCY AT PART-GATE.

Such results, together with its nicely-working gate, and simple, strong, and durable construction, should favourably commend it to the attention of ALL discriminating purchasers. These Wheels are of very superior workmanship and finish, and of the best material.—State requirements, and send for catalogue to

FREDERIC NELL, 16, Mark Lane, LONDON, E.C.

Two 30-inch Victor Turbines fixed on a Horizontal Shaft, and giving out over 500 H.P., are at work driving THE LARGEST DYNAMO IN THE WORLD for Messrs. the Cowles Electric Smelting Company, Lockport N.Y., and Two 12-inch giving out 166 H.P., and driving a No. 8 BRUSH DYNAMO, for the Aspen Electric Company, Aspen, Col. 2065



AUSTIN'S

"INFANT" DYNAMOS & MOTORS

Specially constructed for practical working. First-class workmanship and materials. Electrically and mechanically perfect. For Lighting, Plating, Transmission of Power, &c., &c.

Size,	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6
Output in Watts	50	100	200	400	700	1,000
Per Cent. Efficiency	75	78	80	84	88	92

LONDON AGENTS:
Messrs. PATERSON & COOPER, Pownall Rd., DALSTON, N.E.

PRICE LIST AND PARTICULARS ON APPLICATION.

H. AUSTIN, Florence Electrical Works, ARMLEY, LEEDS. 3848

INDEX TO ADVERTISEMENTS.

The names of Advertisers, whose announcements are ordered for a series, are entered under any one Heading in this Index free of charge but if repeated under other headings, 6d. per week is charged for each additional entry.

PAGE

- **Accumulators.**
  - Crompton-Howell Elec. Storage Co.
  - Drake & Gorham ... ...
  - J. Stiff & Sons (Boxes only) ...
  - Woodhouse & Rawson ... 7 & 13
- **Arc Lamps.**—J. H. Holmes & Co. *Sup.* 11
  - Johnson & Phillips 1
  - F. M. Newton & Co. 17
  - Planet Elec. Engineering Co. ... 5
  - Poole & White ... ... *Sup.* 17
  - J. & W. Roper 14
  - Simplex ... ... *Sup.* 8
  - Statter & Co. 19
  - Woodhouse & Rawson ... 7 & 13
- **Asbestos.**—Bell's Asbestos Co. 20, 21
  - United Asbestos Co. 3
- **Auctioneers and Valuers (Mechanical).**
  - Wheatley Kirk, Price & Goulty *Sup.* 11
- **Batteries.**—India-rubber Co. ... 24
  - Johnson & Phillips 1
  - Telegraph Mfg. Co. ... *Sup.* 4
  - Woodhouse & Rawson ... 7 & 13
- **Battery Jars.**—J. Bourne & Son ... 15
  - J. Stiff & Sons ... .
- **Bells.**—Genl. Elec. Co., Ld. ... *Sup.* 10
  - Poole & White ... ... *Sup.* 17
  - Sheppard, Allarton & Madeley ...
  - Woodhouse & Rawson ... 7 & 13
- **Belting.**—John White & Sons ... 9
- **Boilers.**—Babcock & Wilcox Co. *Sup.* 2
  - Ewen & Co. ... ... *Sup.* 14
  - Robey & Co. 18
- **Books.**—Berly's Elec. Directory *Sup.* 14
  - Crosby, Lockwood & Son ... ...
- **Cabinet Work.**—W. M. Foxcroft ... 8
- **Castings.**—J & J. Hughes 14
  - Phosphor Bronze Co. 10
- **Chemicals.**—G. G. Blackwell ... *Sup.* 12
- **Dynamos.**—Andrews & Preece *Sup.* 7
  - H. Austin 10
  - Bolling & Lowe 4
  - Charlesworth, Hall & Co. ... *Sup.* 19
  - Gülcher Electric Light & P. Co. 15
  - J. H. Holmes & Co. ... *Sup.* 11
  - Johnson & Phillips 1
  - Laurence, Scott & Co. 23
  - F. M. Newton & Co. 17
  - C. Oppermann 6
  - C. A. Parsons & Co. ... ...
  - J. & W. Roper 14
  - Stanley & Davies ... ...
  - J. G. Statter & Co. 19
  - Woodhouse & Rawson ... 7 & 13
- **Ebonite.**
  - Harburg India Rubber Comb Co. *Sup.* 11
  - D. Moseley & Sons... ... ...
  - North British Rubber Co. ... 19
- **Electrical Engineers and Contractors.**
  - Acme Electric Works 10
  - J. D. F. Andrews & Co. 6
  - Andrews & Preece ... ... *Sup.* 6
  - Appleton, Burbey & Williamson *Sup.* 18
  - Blakey, Emmott & Co., Ltd. ... 6
  - R. Bolton & Co. 14
  - Callender's Bitumen Tel. &c. Co. . 13
  - Charlesworth, Hall & Co. ... *Sup.* 19
  - Crompton & Co. ... ... *Sup.* 20
  - Drake & Gorham ... ...
  - Elliott Bros. ... ... *Sup.* 12
  - General Elec. P. & Traction Co. ...
  - W. T. Goolden & Co. ... *Sup.* 13
  - India-rubber & Telegraph Works Co. 24
  - Johnson & Phillips 1
  - Laurence, Scott & Co. 23
  - Paterson & Cooper 23
  - Rashleigh Phipps & Dawson ... 12
  - C. A. Parsons & Co. ... ...
  - Reid Bros. 13
  - Ernest Scott & Co. 19

- **Electrical Engineers, &c.**—*Cont.* PAGE
  - Ronald A. Scott ... ... *Sup.* 5
  - Sharp & Kent ... ... *Sup.* 13
  - M. Holroyd Smith ... ... *Sup.* 6
  - Swinburne & Co. ... ...
  - Telegraph Mfg. Co. ... *Sup.* 4
  - Western Electric Company *Sup.* 20
  - Woodhouse & Rawson United 7 & 13
- **Electric Light.**
  - Brush Electrical Engineering Co. 12
  - Bernstein Electric Lamp Co. ... 14
  - India-Rubber, G. P. & Tel. Wks. Co. *Sup.* 1
  - Johnson & Phillips 1
  - Laurence, Scott & Co. ... ...
- **Electric Light Carbons.**
  - Cathcart & Peto 9
  - H. & F. Chamberlain 6
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - Johnson & Phillips 1
  - Lacombe & Co. ... ...
  - Poole & White ... ... *Sup.* 17
  - Woodhouse & Rawson United 7 & 13
- **Electric Light Fittings.**
  - Dorman & Smith 11
  - Electrical Accessories Co.... ... 5
  - Faraday & Son 12
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - Rashleigh Phipps & Dawson ... 12
  - Poole & White ... ... *Sup.* 17
  - B. Verity & Sons 14
  - Walsall Electrical Co. 16
  - Woodhouse & Rawson ... 7 & 13
- **Engines for Electric Light.**
  - W. H. Bailey & Co. 18
  - Browett, Lindley & Co. ... *Sup.* 3
  - Charlesworth, Hall & Co. ... ...
  - Davey, Paxman & Co. 12
  - Greenwood and Batley 4
  - Griffin Gas Engine 9
  - Marshall, Sons & Co. 19
  - John Musgrave & Sons ... *Sup.* 2
  - Ransomes, Sims & Jefferies ...
  - Robey & Co. 18
  - Stockport Gas Engine ... ...
  - Willans & Robinson ... *Sup.* 19
- **Enamel.**—Aspinall & Co. ... ...
- **Engraving.**—Gilkes ... ...
- **Fibre.**—David Moseley & Sons ...
- **Glass Manufacturers.**
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - Poole & White ... ... *Sup.* 17
  - Woodhouse & Rawson ... 7 & 13
- **Incandescence Lamps.**
  - Brush Electrical Engineering Co. 12
  - Poole & White ... ... *Sup.* 17
  - Sunbeam Lamp Co. ... *Sup.* 3
  - Woodhouse & Rawson United 7 & 13
- **India-Rubber.**
  - India Rubber, G. P. & Tel. Wks. Co. 24
  - D. Moseley & Sons ... ...
- **Insulators, &c.**—Bourne & Son ... 15
  - Poole & White ... ... *Sup.* 17
  - Stiff & Sons ... .
  - Telegraph Mfg. Co. ... *Sup* 4
  - Woodhouse & Rawson ... 7 & 13
- **Iron and Steel.**—Turner Bros. *Sup.* 12
- **Lubricants.**—W. H. Willcox & Co. ... 3
- **Magnet Steel.**—G. P. Wall 17
- **Manufacturing Electricians.**
  - Croggon & Co. 2
  - Dorman & Smith 11
  - Elliott Bros. ... ... *Sup.* 12
  - J. T. Gent & Co. 14
  - A. B. Gill & Co. 6
  - Hartmann & Braun ... ...
  - International Electric Co. ...
  - King, Mendham & Co. 17
  - Laurence, Scott & Co. ... ...
  - Nalder Bros. ... ... *Sup.* 9

PAGE

- **Manufacturing Electricians.**—*Cont.*
  - Poole & White ... ... *Sup.* 17
  - Price, Talbot & Co. ... *Sup.* 2
  - Telegraph Mfg Co. ... *Sup.* 4
  - H. Thorpe 6
  - Walsall Electrical Company ... 16
  - Jas. White ... ...
  - Woodhouse & Rawson United 7 & 13
  - F. Zöpke ... ... *Sup.* 14
- **Mica.**—McGoune, Buchanan & Co. *Sup.* 12
  - F. Wiggins & Sons 8
- **Motors.**—Charlesworth, Hall & Co. ...
  - Cuttriss & Co. 6
  - Gülcher Electric Light & P. Co. 15
- **Patent Agents.**—H. Gardner .. 3
  - J. G. Lorrain ... .. *Sup.* 12
- **Pole Finding Paper.**—O. Berend & Co.
- **Poles.**
  - Johnson & Phillips (Wood and Iron). 1
  - Joseph Aird (Wrought Iron and Steel).
- **Porcelain Appliances.**
  - Dorman & Smith 11
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - Poole & White ... ... *Sup.* 17
  - Taylor, Tunnicliff & Co. ... *Sup.* 12
  - Woodhouse & Rawson ... 7 & 13
- **Porous Cells.**—J. Stiff & Sons ...
- **Projectors.**
  - Charlesworth, Hall & Co. ... ...
- **Railway Signals.**—Saxby & Farmer 12
- **Schools and Classes.**
  - School of Telegraphy 23
- **Screws.**—Davis & Timmins 22
  - A. Stokes & Co. ... ...
- **Switches.**
  - Appleton, Burbey & Williamson *Sup.* 18
  - Faraday & Son 12
  - Genl. Elec. Co., Ld (G. Binswanger.) *Sup.* 10
  - The Paiste Switch... ... *Sup.* 3
  - Poole & White ... ... *Sup.* 17
  - Walsall Electrical Co. 16
  - Woodhouse & Rawson United 7 & 13
- **Telegraph Engineers.**
  - Buller, Jobson & Co. ... *Sup.* 1
  - Johnson & Phillips 1
  - J. Slater Lewis ... ... *Sup.* 7
  - Telegraph Mfg. Co. ... *Sup.* 4
- **Telephones.**
  - Consol. Tel. Const. & M. Co. *Sup.* 6
  - Universal Telephone Co. ... ...
- **Tools, Lathes, &c.**
  - Chas. Churchill & Co. 17
  - J. Jardine ... ... *Sup.* 12
  - Selig, Sonnenthal & Co. 8
- **Tubes.**—Joseph Aird 2
- **Turbines.**—F. Nell 10
- **Wire (covered).**
  - Fowler-Waring Cables Co. ...
  - W. T. Glover & Co. 2
  - W. T. Henley's Telg. Works Co. ... 4
  - London Electric Wire Co. *Sup.* 1
  - Phillips Bros. 23
  - Poole & White ... ... *Sup.* 17
  - W. Rickard 6
  - Telegraph Mfg. Co. ... *Sup.* 4
  - United Electric Wire Co.... ... 6
  - Woodhouse & Rawson United 7 & 13
- **Wire (uncovered).**—Davis & Timmins 22
  - Ramsden, Camm & Co. 15
  - F. Smith & Co. 8
- **Wire Covering Machinery.**
  - T. Barraclough & Co. 6
- **Wood Casings.**—
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - Poole & White ... ... *Sup.* 17
  - Vigers Bros. 14
  - Woodhouse & Rawson United 7 & 13

BOOK ADVERTISEMENTS APPEAR ON Page 14 OF SUPPLEMENT.

MISCELLANEOUS ADVERTISEMENTS *relating to Situations, Articles for Sale and Wanted, &c., &c., appear on Sup. 11 (middle of paper.)*

CROMPTON & CO., LIMITED SEE SUP. 20.

Telephone No. 2,914.

Telegrams: "Faraday," London.

FARADAY & SON'S

ELECTRIC LIGHT FITTINGS.

SPECIALITIES IN DOMESTIC LIGHTING.—Decorative Fittings, Reading Lamps, Vertical and Lateral Counterweight Pendants, Picture Lights, Adjustable Reflectors, Fittings convertible for wall or table use, Universal Jointed Brackets, &c.

3, BERNERS STREET, W.
Works: 9 & 10, NEWMAN MEWS.

INTERLOCKING THE LOCK AND BLOCK.

The Board of Trade have again and again urged the necessity of combining the "Lock" and "Block" systems by actual connection between the Telegraph Instruments and Locking Levers, to effect "inter-dependent working." This great improvement, together with Supplementary Automatic Train Action, has been reliably accomplished and brought into practical use on several lines by Messrs. SAXBY & FARMER, under protection of various Patents granted or assigned to them. *Diploma of Honour (the Highest Award), Edinburgh*, 1890. For Particulars, Plans, and Estimates, apply to

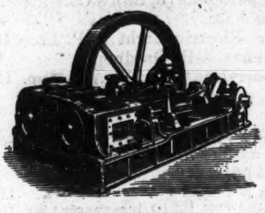
SAXBY & FARMER, Railway Signal Contractors Canterbury Road, KILBURN, LONDON, N.W.

Manufacturers of Railway Signals, Cabins, Interlocking Levers, Block Instruments, and Signal Work of every description, Electrical and Mechanical. 1442

DAVEY, PAXMAN & Co., Engineers, COLCHESTER,

Devote special attention to

STEAM ENGINES AND BOILERS REQUIRED FOR ELECTRIC LIGHT INSTALLATIONS.

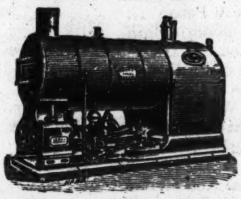


Compound Fixed Engine. 8 to 100 H.P. nom.

D. P. & Co.'s Engines are the cheapest, most durable and most reliable in the market.

Competitive Trials at Newcastle, July, 1887 open to all Makers. The only prizes offered by the R.A.S.E. for Steam Engines, &c. £300 for Best Compound Portable Engine, £100 for Best Single Cylinder Portable Engine, were awarded to D. P. & Co.'s Engines for Extreme Economy in Fuel, Excellence of Design, and Smooth and very Regular Working. This record is 54 per cent. lower than that of the most Economic Engine at the Cardiff Trials in 1878.

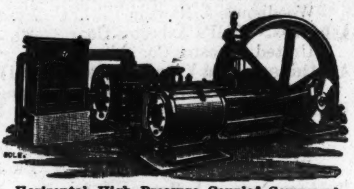
Telegraph Address:— PAXMAN, COLCHESTER.



Patent Semi-fixed Compound Engine and Boiler. 6 to 70 H.P. nom.

Catalogues, Price Lists, and full particulars Post Free on application to

MAKERS OF
Portable Engines. Semi-Portable Engines.
Semi-Fixed Engines and Boilers.
Horizontal Engines.
Vertical Engines and Boilers. Horizontal Winding Engines.
Vertical Hoisting Engines and Boilers.
Compound Portable and Semi-Portable Engines.
Compound Semi-Fixed Engines and Boilers.
Compound Horizontal Fixed Engines.
Cornish, Lancashire, and other Boilers.



Horizontal High Pressure Coupled Compound Engine. 12 to 100 H.P. nom.

PARIS EXHIBITION, 1889.

D. P. & Co. have been awarded Two Gold Medals and One Silver Medal for their Steam Engines and Boilers.

DAVEY, PAXMAN & CO., Engineers, COLCHESTER.

LONDON OFFICE: 78 [late 139], QUEEN VICTORIA STREET, E.C. 2066

THE BRUSH ELECTRICAL ENGINEERING CO.,

LIMITED,

Offices:—112, Belvedere Road, LAMBETH, S.E. Works:—Victoria Works, LAMBETH, LONDON.
"FALCON" ENGINE AND CAR WORKS, LOUGHBOROUGH, LEICESTERSHIRE.

REDUCTION IN PRICE

OF

BRUSH 11 mm. SOLID COPPERED CARBONS.

Brush 11 mm. diameter Solid Coppered Carbons are now sold at **£4 10s.** per **1,000** packed and delivered f.o.b. London.

MANUFACTURED specially for Brush **2,000** Nom. C.P. Arc Lamps, and the best, cheapest, and longest burning Carbon in the Market.

BEWARE of cheap and inferior imitations.

Telephone No. 3975. Telegrams: "DETECTOR, LONDON."

RASHLEIGH PHIPPS & DAWSON.

SHOW ROOMS: 53. BERNERS STREET, LONDON, W.

The Best and most Artistic Show of Fittings in London.

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS.

COMPLETE INSTALLATIONS, OR WIRING ONLY, CARRIED OUT PROMPTLY. ALL WORK GUARANTEED. TRADE SUPPLIED.

NEW PATENT CEILING ROSE,

Approved by all the Fire Offices and Supply Companies, 1s. 1d. net. "The most Perfect Ceiling Rose in the market."

WORKS: WELLS MEWS, W. 2211

HARVARD COLLEGE
DEC 1 1890
LIBRARY

THE TELEGRAPHIC JOURNAL AND
ELECTRICAL REVIEW.

VOL. XXVII. NOVEMBER 21, 1890. No. 678.

CONTENTS:

PAGE
Our Defences ... 605
General Instructions for Overhead Line Construction for Electric Railways (*illustrated*) ... 608
The Alternating Current Transformer System in South America ... 611
The Evolution of the Microphone (*illustrated*) ... 612
Electric Lighting in Mines and Damp Situations (*illustrated*) 615
South Australian Postal and Telegraph Conference ... 616
Some Notes on Gutta-percha ... 617
The Argentine European Cables... ... 617
Electricity and Mining (*illustrated*) ... 618
Trials of a Willans-Kapp Dynamo ... 619
Notes on Central Station Electric Lighting ... 619
London County Council ... 623
The Electrical Behaviour of Certain Amalgams ... 623
Fire at Grosvenor Gallery Central Station ... 624
Notes ... 625

PAGE
City Notes, &c. :—
The Swan United Electric Light Company, Limited ... 629
The Allgemeine Elektricitaets-Gesellschaft ... 629
Blackpool Electric Tramway Company, Limited ... 629
Eastern Extension Telegraph Company ... 629
Traffic Receipts ... 629
Share List of Electrical Companies ... 630
The Electro-Magnet (*continued*) ... 631
New Patents ... 633
Abstracts of Published Specifications ... 633
Correspondence :—Alternating Current Meters ... 634
High-Handed Proceedings ... 634
Note on Localisation of Faults in Electric Light Circuits (*illustrated*) ... 635
The Life of Glow Lamps ... 636
Telopy or Telephany... ... 636

OUR DEFENCES.

THE subject of our defences is one which, possibly, it may be argued, does not strictly come within our province. It is not for a technical journal, professedly an electrical organ, to encroach upon what may be regarded as the domain of military or naval administration. Nor is it in any such spirit we approach the question, but rather as a representative of a factor—and an important factor—of that force which must form an element in the consideration of the subject.

Regarded from that narrow and circumscribed standpoint which looks at everything which is said and done, as the outcome of some selfish and personal interest, it will possibly be said that the remarks we have to offer are prompted in the interest of that branch of manufacture, and in the extension of that application of science which we represent. We will ask our readers, and our critics, to believe that we are capable of being animated, as we think we have not unfrequently shown, by other and more noble desires. The subject to which we desire to direct attention is doubtless one which may be more forcibly brought under the notice of the general public by our influential daily contemporaries, and we very heartily and very earnestly seek their co-operation.

It is now some year or more since we, in referring to the Naval manœuvres which had then come to their close for that year, called attention to the need of providing for the defence of many of our chief seats of mercantile naval commerce. The proceedings of the attacking force then illustrated how deplorably all our mercantile ports were open to attack, and we suggested that it would be well for the Government and the nation to take into consideration what would be the position of our commerce and our coast defences were we brought face to face with a real, instead of an artificial, enemy. We then suggested the desirability of establishing, at various points, depôts of such material as might be stored, against the moment of its requirement. What steps have been taken towards this, or towards any other means of defence, we fear has been exceedingly small; so small, that were England placed upon its defence to-morrow, her only chance would be that sheer bulldog tenacity—that determination never to be beaten which has characterised our forefathers in all our engagements, which would have, if possible, to pull us through. How far this would be successful with the scientific advances made by other nations is an open and a somewhat doubtful question. British pluck and British determination will go a long way where the weapons are equal, but is our provision on an equality with our neighbours. What steps are we taking for the defence of our commercial ports? As we previously pointed out, supposing it should become necessary to lay down a series of marine mines for this purpose, what provision in men and material is being made towards it? Is it not a fact that, so far as the country is concerned, there exists but one recognised source, viz., the Royal Engineer corps, for furnishing the former? Is it possible they could meet such demands, and at the same time comply with the requirements of that duty for which they were primarily created? Why, then, if civilian aid is to be called upon, are we not establishing it? We have no lack of volunteer enterprise for other branches of military or naval defence; but here we are dealing with something novel—something which requires, and must have, the support and recognition of the Government; which must, in fact, be initiated by that authority. Are we so supine as to suppose there will be time to organise all this when we get notice of its need? To be prepared is not to court war—rather the reverse. Neither England nor any other country can afford to stand idly by waiting till the time comes for action. All must be prepared, so that should that time, unhappily, ever come, action may be prompt and decisive, as we may rest assured it will be by others, if not by ourselves.

Our attention has been more than ever forcibly directed to the subject by a paper read before the New York Electrical Society last month, and which we published in full in our previous number. This paper was from Lieutenant Fiske, of the United States Navy, and is entitled "The Civilian Electrician in Modern War." Lieutenant Fiske's name will probably be for ever associated with the tactics of American naval warfare and coast defence, for to him certainly will belong the inception and the credit of applying electrical science to those objects. The paper is one which might well be considered by our authorities and by the public at large interested in home defences. It is necessary we should be alive to the fact that electricity, as stated by Lieutenant Fiske, "has come into use as one of the great factors in warfare, both on sea and shore, not as an adjunct merely, as for lighting ships and forts, but as a vital element in the handling of weapons in actual battle, and in the construction of new instruments which accomplish things heretofore impossible." The modern war ship, if to be used as a concentrated mass of energy, to overwhelm and crush her adversary, must be capable of being handled, as Mr. Fiske states, from one central point, by one individual, so placed that he can see and command all around him. The handling of such a vessel, the direction of her guns, the moment of their discharge—all this, together with a multitude of other minor matter, all come within the provision of electrical agency. The illumination, the healthfulness of the vessel, are aided by its means, and by its means she may surround herself by a cordon of explosives against which her opponent dare not dash herself. On board ship the fighting officer must be in the midst of the smoke of the battle, but on land this need not be so. Stationed apart from the smoke, the noise, and confusion of the attack he may, at a distance sufficient for his purpose, observing all that passes, guide the defence by the aid of that power which also enables the gunner to concentrate his battery, and to discharge it at the point, and at the moment when it shall deal its most efficient blow.

Still, multitudinous as are the applications of electricity to forts and to ships, in torpedo or submarine mining, it will be found of no less importance; and, as we have previously urged, no more ready, no more speedy means of preparing for defence exists than is to be here found. But how can it be used, how can it be installed without men capable to handle such work. It is idle to look to the War Office resources as they at present stand. Either the War Department should establish a corps, sufficiently large to deal promptly with the entire coast defence, or the Government should institute local volunteer corps, officered and manned, subject of course to the responsible local military authority, by local residents. Every facility should be afforded such corps for practice. Depôts of material should be established, and everything necessary for actual defence, as far as possible, provided for. The Mersey, the Clyde, the Tyne, the Thames, and other important and strategical points would not be slow were it announced that the Government were prepared to deal with this subject in a broad and liberal manner, in responding to such a call. In no other way do we see it possible to approach this most important question. We heartily commend Lieut. Fiske's paper to the perusal of our naval and military authorities. From it they will learn to what extent others are preparing for the dire emergency of war—a war which, when it does come, will be one in which science, and especially electrical science, will play the most important part. When war comes, no matter what our preparation may be, it will still find plenty wanting. Let our preparations be ever so great, let us feel that we are even prepared, and there will yet be far more to do than can be done at the time. How, then, if we are found as we are at present? We heartily trust that our contemporaries may, as we suggest, take the question up and bring to bear upon it their influence, and that the result may be that movement we are so desirous of seeing—a movement on the part of the authorities to provide the necessary means for the defence of our coasts, and a responsive movement on the part of those who possess the ability and the time to volunteer their services for the work.

Count Mattei's Remedies.

WITH commendable zeal Mr. Alfred W. Stokes, public analyst to Paddington, Bethnal Green, and St. Luke's, has undertaken an investigation into the genuineness of the "Electricities" remedies of Count Mattei. Mr. Stokes states, as the result of his investigations, that as regards the liquids "To delicate test-paper they were perfectly neutral. Vegetable extracts are usually either alkaline or acid; even if neutral when fresh, they speedily change. They had the following characters:—Colour, odour, taste, polarity, metals, and alkaloids, none; specific gravity (distilled water = 1) 1·0006 elettricita bianca, 1·0002 elettricita verde, 1·0002 elettricita rossa; solid matter in 100 parts, 0·01 elettricita bianca, 0·01 elettricita verde, 0·01 elettricita rossa. The microscope showed an absence of any floating particles or sediments such as are usually present in vegetable extracts. There is but one substance which possesses all the above qualities, that is water. None of these fluids differ at all from water in any of their properties." So far the analysis seems to have been conducted in a reasonable manner, but when we come to the electrical investigation we find as gross an ignorance of elementary electrical laws displayed as can well be imagined. Mr. Stokes writes:—"To find if they possessed any special electrical properties, they were placed singly in thin glass tubes; these tubes were suspended by silk filaments. Under such circumstances an electrical body would point one end to the north and the other end to the south. Not one of these came to rest in such a position; neither were any of them attracted by a magnet, as an electrical body would be. Hence, they certainly are not electrical." Comment is needless. Mr. Stokes should be at once secured by Mr. C. B. Harness.

Something out of Nothing.

"NOTICE is given of the closing of the transfer books of Elmore's Foreign and Colonial Patent Copper Depositing Company for the purpose of paying a dividend." So say the newspapers. This dividend must, of course, be out of the floating of sub-companies. What too strong can be said of this whole business of floating company after company without having once proved the intrinsic value of the Elmore process? Only company promotion and dividends therefrom support the fiction, but none the less evil will be the day when all the facts connected with the process and its present handling are known, and they cease to tempt either the ignorant investor or him who hunts for premiums.

The Loss of the *Serpent*.

THE excuses, or reasons, given for the loss of H.M.S. *Serpent*, such as the effect on the compasses produced by the vicinity of large quantities of iron ore on land, the "humbugging" of the compasses owing to the magnetism of the hull being affected by the buffeting of the waves, and the ship's course being thrown out by a strong current, savour of too much protest on the part of those in authority. Thousands of merchant steamers are continually passing Finisterre, and unless a merchant captain had some better excuse to give than either of the above for the loss of his ship, his certificate would be in considerable jeopardy.

Another Subway Explosion.

ON Wednesday afternoon, last week, another alarming occurrence took place in connection with electric lighting in Newcastle, at the corner of Pilgrim Street, New Bridge Street and Northumberland Street. A few days ago, it will be remembered, the cover of an electric light junction box in the pavement blew off in that neighbourhood. On Wednesday afternoon, a puff of smoke was observed to issue from the same box-cover. Nothing further happened to this box, but the covers of two other boxes in the locality almost immediately blew off. Fortunately, at the time of the occurrence, comparatively few persons were about, and no one was injured. The utmost alarm, however, was felt by the residents in the locality owing, as stated, to a similar accident having occurred so short a time ago. The opinion expressed by the workmen is that the explosion had been caused through an escape of gas. Writing to us on this topic Mr. Arthur E. Gilbert makes the following comment :—"Surely my system of ventilation, which you illustrated some months ago, would obviate these serious explosions. No ventilation appears to be provided for, or even considered essential, but for safety I think you will say it is essential."

Some Experiments in Electrolysis.

IN a recent issue of *The Chemical News*, Mr. P. L. Aslanoglon describes some rather empyrical experiments which he has conducted on the electrolysis of various substances. He passed the current from six Fuller's mercury bichromate elements through various solutions and obtained the following results :—Water containing calcium, magnesium, barium, strontium, or zinc hydrogen carbonate yielded, when the current was passed, a deposit of the normal carbonate of the metal at the negative electrode, and at the same time both oxygen and hydrogen gases were evolved. There was the same evolution of gases when the current was passed through a solution of ferrous carbonate, but the carbonate remained unchanged: there was no deposit. A solution of silver chloride in aqueous sodium thiosulphate, yielded under similar treatment a deposit of metallic silver: hydrogen was evolved, but no oxygen. In this case an odour of sulphuretted hydrogen was observed. When lead sulphate dissolved in ammonium tartrate was subjected to the same treatment, a black substance was deposited at the negative pole: it gave off an ammoniacal odour. The positive pole and the liquid became yellow, and there was an evolution of oxygen and hydrogen gases. It is a pity Mr. Aslanoglon's work has not been quantitative. We need hardly point out how much more valuable such researches are, and it is to be hoped that the experiments will be repeated with solutions of known strength, and that in each case the resulting substances will be carefully analysed.

Electricity.

THE new journal has appeared, and we notice an error in the second sentence. "Fifteen years ago," says the editor, "a paper exclusively devoted to electrical matters would have had no *raison d'être*," and yet the ELECTRICAL REVIEW has been steadily making its way since the year 1872. The candid admission, too, that it is not intended to supersede any of the existing papers is welcome news, and once again we wish our penny contemporary a flourishing future.

Electricity. Daily.

THE *Elektricitäts-Zeitung*, of Berlin, a bi-weekly journal of fifteen issues, is now announced to appear three times a week. The editor is Arthur Wilke, and the hope is expressed that in the near future the paper may appear every day on the breakfast table of those people interested in electro-technics, in common with their other daily periodicals.

Fire at Grosvenor Gallery Station.

ON Saturday last the Grosvenor Gallery Central Station, belonging to the London Electric Supply Corporation, was destroyed by fire. The place was left in charge of a linesman, who, while endeavouring to switch off a converter, failed to firmly fix the plug between the two terminals, which caused an arc to form. The details of the mishap, which in less than an hour's time left the station completely gutted, are given in another column, but doubtless the fear of getting a shock from a current of 5,000 volts pressure, even if such a thing were impossible, was the cause of the man's loss of nerve. The instruments and converters were destroyed, business for the present being entirely suspended, and, will it be credited, the loss is not covered by insurance. Coming to the cause attributed in the foregoing remarks, there appears to have been some laxity in a method of management which leaves an inexperienced man in such a responsible position, for inexperience and responsibility are shown by the results. Grave censure is without doubt due somewhere, but one could not for a moment cast blame upon a man who is actually admitted to be new to the work. We are afraid customers who may have been entirely dependent on the supply of current for light may not take a too favourable view of the accident. It must not be thought, however, that we fail to appreciate the many difficulties and troublous times through which the company has passed, and this crowning disaster, coming as it has just when the Deptford Station seemed to promise to keep up the complete supply for the company's system, is doubly disheartening, and we sincerely sympathise with Mr. Ferranti and his supporters, and express the hope that they may soon tide over their ill-luck.

GENERAL INSTRUCTIONS FOR OVERHEAD LINE CONSTRUCTION FOR ELECTRIC RAILWAYS.

THE large amount of overhead railway work now in course of construction, and the large number of roads which will undoubtedly be constructed in the future, makes it desirable to have some clearly defined rules for the construction of overhead work, as well as that relating to the ground conductor. Our readers (New York *Electrical Engineer*) will therefore be interested in the admirable general instructions relating to this part of railway work, which have been issued by the Westinghouse Electric and Manufacturing Company, and which, if carried out faithfully, cannot fail to result in a substantial and lasting conductor system, with the least possible annoyance to the public.

Franchises, Permits, &c.—The owners of the railway must secure all necessary franchises and permits from public authorities, or private individuals, for properly carrying on the work of construction, including permission to set poles in the most advantageous positions, and to run guys where necessary. They shall also do all necessary removal or trimming of trees, and shall be responsible for all necessary removal of existing wires or poles or other impediments.

Contractors.—The contractors shall comply strictly with the local laws governing their work, and are responsible for all unlawful damage done by their *employés* in the progress of their work. They are required to do all the carting and storing of material, to furnish all horses, waggons, men and material for carrying on work.

Completion of Work.—Each branch of the work must be pushed rapidly to completion as taken up, all re-sodding, paving, &c., promptly done, and all *debris* and material removed. All breakdowns, or deteriorations of the work, which shall occur before the final completion and acceptance of the whole, shall be repaired and made good by the contractors at their own expense.

Inspection and Acceptance of Work.—The Electric Company may appoint an inspector, who shall have authority to decide and direct how every branch of the work shall be done, and what material shall be used. He may at any time order such changes and removals as he may see fit. If the inspector orders any work done or materials used which are not properly included in, or covered by, the contract, he shall give a written order to the contractors, specifying, as nearly as possible, the amount of labour and material involved. The inspector will give a written acceptance to the contractors when he considers their work properly completed.

TRACK AND GROUND CONNECTIONS.

On all roads where the size and material of the continuous ground wire are not particularly specified, No. 0 B. and S. galvanised iron wire shall be used. All joints in it shall be soldered. It shall be stretched taut, and secured to cross-ties or stringers with galvanized staples. It must be so deep in the ground that it cannot be reached by wheels, &c. It must be run close to one rail, and connected to each rail bond it passes by a wrapped soldered joint. Every 150 feet a branch of No. 0 B. and S. wire shall be soldered to the continuous ground wire and to a rail bond on the other side of the track. Where there is a double track, there must be a cross wire every 150 feet, which is soldered to bonds on ground wire on all four lines of rail, and is the only cross connection required. It must be of No. 0 B. and S. (See fig. 1.)

Between the ends of all consecutive rails, of whatever form, a rail bond, the Electric Company's standard pattern, shall be used. This bond is shown in fig. 1. The holes in brass or copper block must be bored to fit rivet and wire, not punched. The end of wire must be put through block, and upset so that it cannot pull out, and the whole bond must be covered with half-and-half solder. The rivet must be Norway iron, $\frac{5}{16}$ inch in diameter, and of just sufficient length to pass through flange or web of rail and be riveted.

The best place for rivet holes in different kinds of rails depends to a great extent on paving and other conditions. The rivet must always pass through the rail, and be upset into a counter-sinking at the end of hole. No part of the bond must be exposed or placed in such a manner that it can be touched by wheels or that the movements of the rail will tend to break the wire. The admissible positions for rail bond rivets in girder, T and tram rails are shown (fig. 2). No rail bond may be less than 10 inches in length, and the bonds must be slack when in place, but as short as the conditions will permit. Where short pieces or castings, such as switches, frogs, or curve castings, occur in track, the pieces must be connected up in the same manner as consecutive rails, and each bond soldered to the continuous ground wire.

In steam railway crossings, each piece of rail must be connected to the continuous ground wire. Where a draw bridge is crossed the rails on either side should be connected by a No. 0 B. and S. copper wire, weighted to the bottom of water, with such connection as is necessary for rails on draw.

Cables or wire leading from rails to dynamos must be soldered to continuous ground wires and bonds on all lines of rails, and must be connected to the positive terminal of dynamos. When ground feeders are run, they must be insulated in the same way as line feeders, but must, if possible, not be run on the same line of poles, and in no case must they be run on the same insulated pole tops.

POLES.

Wooden Poles.—Must be 30 feet long, and, for use on straight lines must not be less than 7 or more than 8 inches in diameter at top when finished, and they must not be less than 10 inches in diameter 5 feet from the butt. They must be of sound chestnut, cedar or Georgia pine, may be sawed or natural round, but in both cases must be dressed smooth and coned at top, cones having two coats of paint.

Poles for Corners.—At curves, and for the ends of line, or which in any way bear part of the pull of the trolley or feed wires, must be not less than 8 inches in diameter at top and not less than 12 inches at a point 5 feet from the butt. All poles must be straight and uniform and free from shakes, checks or large knots.

Iron or Steel Poles.—Of whatever form shall be of a strength and stiffness at least equal to the wooden poles specified. A pole made of three sections of extra heavy pipe, top section 3-inch pipe 5 feet long; middle section 4-inch pipe 6 feet long, and bottom 5-inch pipe 16 feet long (these lengths do not include the lap in joints), is sufficient for light work. All joints must be made perfectly rigid and as strong as the adjoining pipe, with proper provisions against telescoping.

All iron poles must have a thoroughly insulated iron top, to which wires are secured. This should be mounted in a hard-wood plug in pole top, boiled in paraffin. The top must protect the plug entirely from water; it must have a deep petticoat extending at least 1 inch below pole top, and standing at least 1 inch clear of it on all sides. This top must be fitted with fixtures for securing span wires and insulators for feed wires, &c.

For Curves.—Angles of feed wire, and ends of line, &c., extra strong poles must be used. There is nothing in the work of building a line so essential to its durability and good working as is the perfect rigidity of corner poles. The top section of curve poles should in no case be less than 5-inch extra heavy pipe, and, of course, special insulated tops must be provided for them. Corner poles must be fitted with strong eyebolts below the wooden plug for fastening guys.

Pole Setting.—All poles on straight line work shall be set 6 feet in the ground. Large stones shall be tamped hard against butt of pole on side away from rails. Where practicable, pole should bear at surface of ground against curb stone, or have the space between it and curb stone filled by another stone or stones. Where there is no curb stone, a timber not less than 4 × 8 inches and 3 feet long shall be laid against the rail side of pole, 6 inches below the surface of the ground. A large stone, at least 2 feet long and 1 foot wide, should be used in place of timber when practicable. All poles shall be tamped solidly. (Fig. 3.)

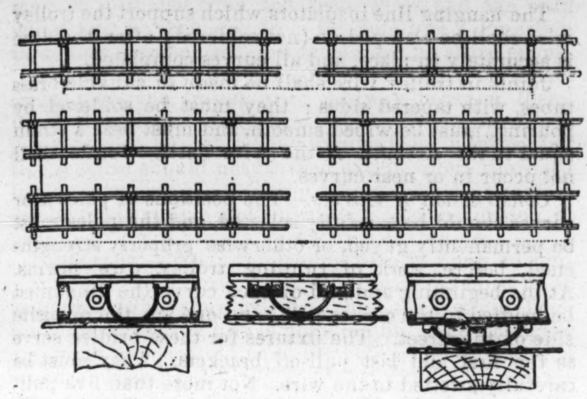


FIG. 1.—METHOD OF CONNECTING GROUND WIRE, SINGLE AND DOUBLE TRACK.

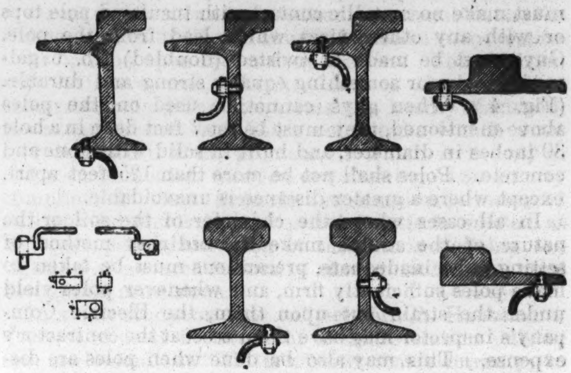


FIG. 2.—METHOD OF CONNECTING GROUND WIRE TO RAIL.

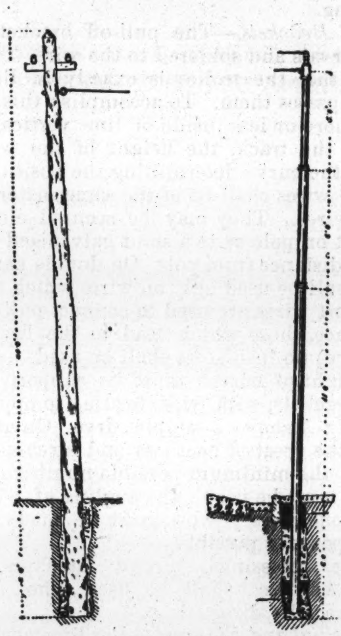


FIG. 3.—METHOD OF PLANTING WOOD POLE AND IRON POLE.

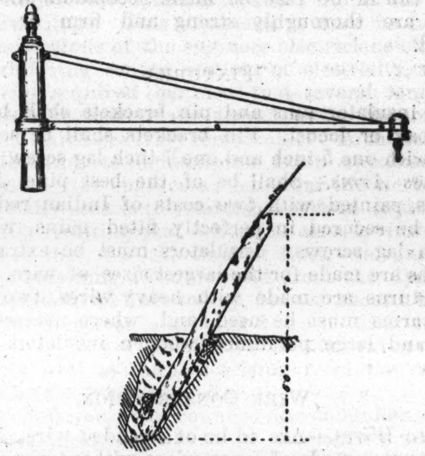


FIG. 4.—GUY STUB AND OUTRIGGER.

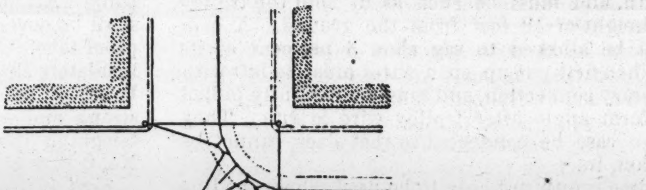


FIG. 5.—METHOD OF CONSTRUCTING OVERHEAD CURVE.

In setting iron poles, good cement concrete must be used. The quality of the concrete should in all cases be good at the top and bottom of holes, and large stones may be used at these points to advantage. The hole in which an iron pole is set should be at least 20 inches in diameter, and filled with concrete, which should be given ample time to set before any strain is put on it. Poles of wood or iron for straight line work should have about 3 per cent. of rake away from street. (Fig. 3.) Wherever possible, the line of the tops of poles should be at a uniform height from rails, and the ground around poles should be graded to give the pole the proper depth of setting.

Poles which support part of the strain of curves or bends of trolley or feed wires must, in all cases where it is possible, be thoroughly head guyed. When this can be properly done, no extra precautions need be taken in setting, and poles should be set nearly vertical. The same applies to poles which support ends of lines.

Guy stubs must be anchored 5 feet in ground, and their tops must be 6 feet above ground; the stubs must be at least 8 inches in diameter, and must rake well towards pole top or point directly towards it. Guys must make no metallic contact with insulated pole tops or with any other wires which lead from the pole. Guys must be made of twisted (doubled) No. 6 galvanised wire or something equally strong and durable. (Fig. 4.) When guys cannot be used on the poles above-mentioned, they must be set 7 feet deep in a hole 30 inches in diameter, and built in solid with stone and concrete. Poles shall not be more than 125 feet apart, except where a greater distance is unavoidable.

In all cases where the character of the soil or the nature of the strains make the ordinary method of setting poles inadequate, precautions must be taken to make poles sufficiently firm, and whenever poles yield under the strain put upon them, the Electric Company's inspector may have them reset at the contractor's expense. This may also be done when poles are displaced by undue strains imposed by contractors in building line, &c.

When the poles are not set by contractors who put up the wires, the latter must assume responsibility for the rigidity of curve and terminal poles, and their work can in no case be made acceptable unless these poles are thoroughly strong and firm or properly guyed.

FIXTURES.

All insulator pins and pin brackets shall be of the best oak or locust. Pin brackets shall be secured to pole with one 5-inch and one 7-inch lag screw.

Cross Arms.—Shall be of the best pine, $3\frac{3}{4} \times 4\frac{1}{4}$ inches, painted with two coats of Indian red. They must be secured in perfectly fitted gains with two 7-inch lag screws. Insulators must be extra heavy, such as are made for the largest sizes of wire. Where sharp turns are made with heavy wires, two or four cross arms must be used, and, where necessary, iron pins and large paraffined wooden insulators may be used.

WIRE CONSTRUCTION.

Span Wires.—Are to be of stranded wire, $\frac{5}{16}$th inch in diameter, made of seven wires without a core. They must be secured to eye-bolts, which pass through pole, and have a nut on the opposite side. These bolts to be of $\frac{1}{2}$-inch galvanized iron. With iron pole a suitable eye must be provided for span wire. The height of eye-bolts from the rail must be uniform on streets of equal width, and must be such as to hold the trolley wire at a height of 19 feet from the ground. A span wire must be allowed to sag abou 3 per cent. of its length. When first put up, span wires must be left with one temporary connection, and must be carefully pulled up to uniform angle after trolley wire is run. They must in no case be connected so that slack cannot be readily taken in.

Span wires proper are only to be used where the line is perfectly straight. Where there is any lateral strain on trolley wire, double pull-off brackets must be used, with wires of the same material as span wires, leading to opposite sides of street.

Trolley Wire.—Must be put up in as long lengths as can conveniently be handled. The ends must be secured to a long V made of double $\frac{5}{16}$ stranded wire, and led from securely guyed poles. It must be connected to this V by an insulator of suitable strength. Trolley wire must be drawn to a moderate tension only, allowing about 18 inches of sag in 125 feet. In hot weather it should be drawn slightly tighter. It must be run off large reels, on which it is carefully wound; it must not be bent, kinked, or scratched. The practice of temporarily securing long lengths of trolley wire, and allowing by guess work for each curve is not approved, as it is sure to cause inequalities of tension in line or improper position of curves. Curves should either be completed as they are reached by the trolley wire, or should be built successively after the wire is up, an ample amount of slack being provided and carried ahead as the curves are completed, the line being permanently drawn to the proper tension, and bridled as each is reached.

The hanging line insulators which support the trolley wire shall be clamped on (not soldered) after the line is accurately in place, and all curves completed.

Joints in trolley wire shall be made in suitable brass tubes, with tapered sides; they must be soldered by pouring, must be wiped smooth, and must bear a strain equal to the strength of the wire itself. Joints shall not occur in or near curves.

Construction of Curves.—The positions of poles near curves should be carefully selected, and the poles must be permanently guyed, or otherwise properly strengthened, before work of running trolley wire begins. At the beginning and end of each curve the line must be bridled to the corner pole, and one on the opposite side of the street. The fixtures for these bridles serve as the first and last pull-off brackets. They must be carefully swetted to the wire. Not more than five pull-off brackets should be used between these bridle fixtures on a 90 per cent. curve, except where the curve is very long.

Pull-off Brackets.—The pull-off brackets shall be at equal intervals and soldered to the wire. They must be so placed that the trolley is exactly in line with the wire as it passes them. To accomplish this, the bracket must be more or less inside of line vertically over the centre of the track, the height of the wire, and the radius of the curve determining the position.

Pull-off wires shall be of the same material specified for span wires. They may be secured either directly to eye-bolt on pole or to a stout galvanized iron ring at a suitable distance from pole. On double curves, &c., insulators shall be used only on wires which run to poles. Where short wires are used to connect pull-off brackets (for instance, those which lead to the brackets on the inner curve) no insulators shall be used.

The weight of curves must be supported by double pull-off brackets, with wires leading to opposite side of street. Fig. 5 shows a sample curve. On all curve construction the greatest neatness and strength will be insisted on; the minimum possible number of wires and insulators must be used; the angling of wires must be advantageous; every wire must be made to serve as many purposes as possible.

Switches, crossings, circuit breakers, lightning arresters, &c., &c., shall be used when and in the manner specially directed.

All Material and Fixtures.—For line work shall be of the form supplied or specified by the Electric Company. All joints and connections in insulated wires shall be covered with three layers of the best weather-proof tape. All ungalvanized iron work and wooden insulators shall be thoroughly and neatly painted with P. and B. paint. Joints in feed wire must be of a neat, strong and approved form, thoroughly soldered. No telegraph joints will be allowed in wires larger than No. 0 B. & S.

Feed Wires.—These must be put up to gauge specified, and must be 97 per cent. of the conductivity of pure copper. They must be put up without kinks or injury to the insulation, and in lengths of not less than 500 feet. Feed wires must be led into the power station through suitable rubber or porcelain insulators. Every connection to the trolley wire must be made through one of the span wires, which must be fitted with an insulator at each end, and connected to the feed wire by an insulated jumper of No. 6 B. and S. wire, soldered to both. Connection to the trolley wire must be made by an insulated hanger, similar in appearance to the regular insulators. These span feed wires must be of the same material as regular span wires, but covered with the best weather-proof insulation. Where feed wires have to be led under water, the best armoured cables must be used, and suitable terminal fixtures.

Guard Wires.—Wherever there is great danger of crosses with telephone, telegraph or other wires, through their falling on the trolley wire, guard wires must be used. They must be of No. 8 B. and S. galvanized iron wire, and must be hung to span wire of the same material as the ordinary span wires. Guard wire must be 18 inches or more above the trolley wire. They must be insulated from the span wires, and the span wires must be insulated from the pole tops. Porcelain insulators may be used, but must have no sharp edges.

On single track work, guard wires must be 4 feet apart, with the trolley wire midway between them. On double track work, three wires will be used, one 2 feet outside of each trolley wire and one in the centre. Guard wires should not be used except where the need for them is very positive, and where their construction can be made simple and effective. A complication of guard wires will always be a source of trouble.

Outriggers.—When the trolley wire is hung to outriggers instead of span wires, the insulators must be so constructed that they will bear the lateral strain from the wire where the line is not straight. The outrigger arm must be insulated from the pole when the latter is of iron. (See fig. 4.)

THE ALTERNATING CURRENT TRANSFORMER SYSTEM IN SOUTH AMERICA.

[FROM A CORRESPONDENT.]

UNDER this title I have some months ago sent you a report on the extension of the above systems in the towns of La Plata and in Brazil. To this report I am now in a position to add some further particulars.

The *Companhia Luz Electrica*, in San Paulo, which, as I informed you, has undertaken the lighting of San Paula and Casa Branca, and has there erected central stations on the alternating current transformer system, has, in the meantime, extended its sphere of activity and its capital. It has undertaken the supply of water, enlarged its capital to five million francs, and has been re-constituted under the title "Companhia Aqua e Luz do Estato de San Paulo."

Above all, the new company has undertaken the extension of the central station at San Parlo, and is erecting an alternating current machine of the type A_5 (for 50,000 watts), with the requisite motor.

The company has further concluded an agreement with the municipality of Ouritzba (the capital of the province Parana), and is bound to get the public lighting there in action by June, 1891, at latest.

At the distance of about 4 kilometres from the town there is water power, which has been taken into consideration as supplying the needful force for the installation to be erected. But at present, owing to torrents of rain, the annual flow of water in the river cannot be ascertained, nor the amount of water-power which will be available. Hence, in the first place, two alternating current machines of the type A_3, for 30,000 watts each, are being erected with two Steinmüller tube boilers and two steam engines by Tangyes, Limited, so that the electrical works will be driven by steam power during the first period. The central station will be erected close to the railway terminus, so that a supply of fuel may be obtained cheaply.

If on further investigation it is found that the project of using water-power can be carried out, a definite conclusion will be come to as to whether the works will be conducted further with steam-power, or remodelled to suit hydraulic power. After the decision of this question, the extension of the works will be taken in hand, so that the demand for private electric lighting in Ouritzba can be duly met.

The computation of the price of the electric light will be carried out according to agreement with the Municipality, after working for a year on the scale of 4,000 candles. The calculation for private lighting will be made after the works have been definitely completed.

THE ELECTRIC LIGHTING OF BRUSSELS.

THE question of the electric light remains open at Brussels, says the *Independence*. The technical departments of the communal administration are studying the different propositions made to the city authorities, and the College and Council will shortly be called upon to give their opinion upon the various tenders. This decision will be grave and difficult. Among the specialists themselves the different systems are keenly discussed, the advantages of each being contested; and it must be recognised that the problem, of which it is easy to claim an immediate solution at a meeting, is singularly complicated. As to Brussels, the situation is rendered still more difficult by the private stations erected at different points, and each of them monopolising the lighting of an area naturally chosen under the most favourable conditions.

In a new study on this subject, M. Ch. Haubtmann declares himself in favour of a single station outside the agglomeration. He is certain that electricity, in addition to its qualities of hygiene and safety, is before everything the lighting *de luxe par excellence*, and if to-day its upward rise is somewhat hindered on account of its relatively high price, the day on which it adds cheapness to its numerous other advantages over gas it will take possession, as gas formerly did, of the most modest dwellings. This cheapness, it may be said, is in the hands alone of the engineer electricians charged with establishing central stations of electricity, and it is by having acquired that idea, that several large installations have been made abroad under economical conditions which are truly remarkable. To induce machinery to output to its maximum extent appears to be the domain of the engineers; but what the electrician must specially seek is to establish a system capable of successfully rivalling that which is already installed. We believe that, for the time at least, we must not reckon on obtaining a better yield from the dynamos than that which we have to-day, but we should exclusively limit ourselves to keeping down to their lowest extent the expenses of installing and the working of the stations, as well as the loss arising from the energy absorbed by the conductors, &c.

This programme, on account of the tolerance which municipal authorities grant to the companies tendering for the lighting, is occasionally easy to carry out. Thus, in America, besides the facilities which are given to these companies of erecting their stations in the centre itself of the sector which they are to supply, that is to say, most often in the centre of the town, no difficulty is raised as to their establishment of aerial conductors. It can easily be imagined that, under these conditions, if coal be cheap enough, the electric light can advantageously compete with gas. But if, on the contrary, as in England, and in London particularly, central stations in the interior of the city are not tolerated, nor aerial cables, the problem becomes singularly complicated, and presents great difficulties.

As to Paris, at first, electrical stations were allowed to be established in the centres of the quarters, but a report of M. Lépine, secretary to the Prefecture of Police, recommends their transfer beyond the walls of the *enciente*. An important city seeks to get rid of the vibration caused by the steam engine at night, which incommodes the neighbourhood of the central stations; without reckoning this, despite all the smoke consumers with which the furnaces are provided, they allow sufficient carbon oxide to escape to reveal to the least inexperienced person the presence of a central electricity station. In short, the problem of electric lighting in large cities may be thus formulated under most general conditions:—to have a station outside the city, and underground cables conducting the electricity to the sector, at a net price capable of competing with gas. This is not impossible now, for the establishment of the station in a place isolated from buildings, in proximity to the means of transport, will procure a real saving in working, and may be, in building over that installed in the centre of the city itself. In this case, the type of boiler which appeared the most economical could be employed without having to take police ordinances into consideration; the furnaces could be placed in such a manner as to suppress troubles regarding fuel; and, in most cases, there would be cheap water, &c. Regarding steam engines, being no longer bound by the position, the types giving the best results could be adopted, and several reserve engines could also be kept. In a word, a number of advantages would be enjoyed which it is impossible to get in the centre of towns and cities; among others, water and fuel at lower net prices, and apparatus giving a maximum of yield.

An outside station will doubtless cost, in establishment expenses, as much as an urban station, because, in the first place, a larger one will be built, and more apparatus will be placed therein, than if it were in the city. On both sides there will be the same building expenses, but there will be more economical production in the case of the station outside the section. There is then a first advantage resulting from conditions imposed by cities; let us say at once that it is compensated by an inconvenience much more important, more especially as regards the value of the system of the company's working. We refer to the loss arising from the transport of energy, which is obliged to be carried on account of the distance of the place of production from the place of consumption, and the expenses of the first establishment of the conductors. The labours of Cabanellas, and some experiments of M. Marcel Deprez, have taught us how to get rid of the major part of this inconvenience by employing high tensions, so that, all allowance being made, an electrical station situated far from the city will be found in an excellent position to compete with gas and the existing urban stations, while admitting that these latter are still tolerated.

We have already had an opportunity of pointing out, when the lectures were given at the beginning of the year before the Belgian Engineers' and Industrials' Society, the great difference existing between continuous currents and alternating currents as regards safety. There remain to be examined to what exigencies should a central station be able to respond before furnishing light and energy. For that, it is sufficient to pass in review what the subscribers to an electricity company have a right to expect from it:—1. To be able at any hour of the day or night to light the required number of lamps, or take the energy which is necessary. 2. To enjoy a light at least as regular as gas; that is to say, without variation in luminous intensity. 3. Not to be at the mercy of a bad installation and canalisation, in understanding by that never being deprived of light, on account of accidents to apparatus, earth contacts, &c. 4. To have no chance of accidents or electric shocks, dangers from fire, &c. 5. To realise as much as possible a saving on the former system of lighting. These five subscribers' conditions are reduced to two for the concessionary company:—1. To possess a central works producing economically and a system of distribution absorbing scarcely anything. 2. To have a reserve system capable of meeting all eventualities, consisting either of accumulators or spare dynamos, according to circumstances.

For a central station, this security consists simply in furnishing, at any moment of the day, the quantity of energy required by the section which it supplies. From this point of view, a station should be able to pass easily from a maximum output to rest and *vice versâ*, and that very rapidly, instantaneously even, if that be possible. For this there are two solutions: To employ batteries of accumulators ensuring the service without the aid of the dynamos for a certain time, or to have dynamos constantly ready to work. In adopting the system with secondary batteries, if the installation is large and situated at a distance from the section, the employment of high potentials becomes necessary; then, in place of having accumulators in the central works themselves, they can be spread over different parts of the line, so as not to be obliged to adopt too large batteries in tension. These accumulators will bring about the disappearance of one of the greatest inconveniences of lighting workings which operate during a short period of the day only, thus giving a bad utilisation of the dynamo.

We will not here enter into the technical details of the installation. We will only mention in conclusion a point which is much contested—the question of the strength of the units of production, on which many engineers seem divided. Should the producing stock be divided as much as possible? Or, on the contrary, should we lay ourselves open to make large dynamos? Each of the two schemes having its good features, we think it wise to adopt a medium course. The small units have the advantage, in case of injury, of rendering useless only a small portion of the total producing power, but they require more room, necessitate greater watchfulness, and cost more for working expenses than larger ones. The larger units, if they remain for a short time out of working, cause a loss, by the interest of the capital which they represent, of the profit which is realised on them by overlooking, yield, &c.; but we believe we are able to say that in dynamos, which are but little susceptible to derangement, powers may be attained which prudence would blame if steam engines were in question. It remains to be known whether these dynamos will always work at full load, for it is evident that an apparatus producing below its nominal power works under very bad conditions of yield.

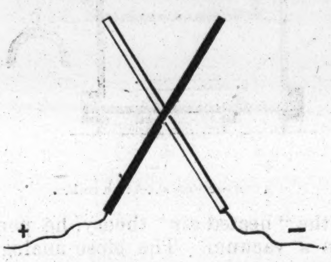
The system of working must, then, be established under such conditions that the dynamos may always work with their maximum of production. For this it suffices to divide the apparatus supplying the total energy into two groups—a group of small units, having a total power, spread over five or six apparatus, equal to the nominal power of one of the dynamos of the other group, composed wholly of large units. It will be immediately seen that with this system of working a large dynamo only works as much as is necessary to produce a similar result to that for which it has been established, and that in proportion as the work demanded increases, one or several of the small dynamos are introduced up to their total energy, a value for which they are withdrawn by again introducing a large unit. This process gives a maximum of yield from the apparatus, and necessitates but few supplementary establishment expenses.

THE EVOLUTION OF THE MICROPHONE.

By A. M. TANNER.

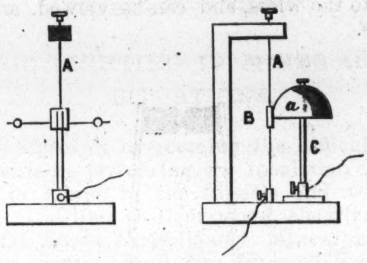
THE object of the present paper is to demonstrate that the microphone did not spring into existence Minerva like, but was the production of a slow growth continuing through several decades; it has several prototypes as will be shown further on. In former articles, which appeared in the ELECTRICAL REVIEW, I drew attention to the fact that certain types of Trevelyan instruments, possessing carbon rockers and bearers, will, under certain conditions, serve as microphones, the most essential condition of course being that the rocking electrode should be made sufficiently light to be affected by ordinary sound waves. The instruments reviewed in the present article do not require a change of form or diminution of weight, but will at once serve as microphones or telephones, having variable contact current tension regulators. In the outset, in order to remove any doubt that may exist as to who first discovered the principle of varying the resistance in a galvanic circuit by electrodes of metal or other material resting in loose contact, one upon the other, and serving to change the tension of the current flowing across said electrodes, not by a mechanically applied pressure, but automatically by a mere change of position or difference of contact between the electrodes, it is necessary to refer to the *Comptes Rendus* of the French Academy of Sciences for 1878, page 131, where Count Du Moncel states that it was not until the year 1856 that he discovered the change of electrical resistance produced by imperfect contact electrodes. This, of course, determines the date of Du Moncel's discovery, and in view of what follows, it is necessary to award the credit of prior discovery to Prof. Albert Mousson (just deceased at the age of 86 years), of Zurich. In the *Nouveaux Memoires de la Société Helvetique des Sciences Naturelles* for 1855, Vol. XIV., appears a lengthy paper of Prof. Mousson on the changes of the galvanic resistance of metals. Among other experiments, mention is made of the variable resistance between springs rubbing upon discs, just as in the electro-magnetic circuit breakers of Du Moncel, when he discovered that a light or strong contact between the contact spring and collector disc will produce a variable resistance.

In fig. 8 of the plate accompanying Mousson's article, he illustrates an experiment with two crossed wires, and he adds that in a loose contact *without pressure*, as when two solid wires are placed one upon the other, the resistance is variable because of the changes of position, or changes of temperature at the contact points. The change of position of the loose contact electrodes is produced by the action of the current itself.



In the *Compte-Rendu* of the 45th session of the Société Suisse des Sciences Naturelles-Lausanne, 1861, is a communication from Prof. Mousson "on the movements that present themselves in a galvanic circuit at the points where the conductors touch each other very lightly." Mousson here describes the experiments of De la Rive in 1845, Rollman and Page in 1850, and Gore and Forbes in 1858, and says that they operated with rolling and rocking bodies.* Mousson in describing his own experiments, says that for a "rocker" he selects a bar analogous to that employed in the Trevelyan experiment only *very much lighter*, and resting upon two knife edges brought close together, set in motion, while the current traverses the point of contact a sound is produced which results from the rocking of the bar on the two knife edges (bearers) and which continues as long as the current passes. Mousson adds that the movement of the "rocker" does not commence by itself, but must be started by an external cause, although sometimes an *imperceptible trembling of a table serves to set it in motion*. In order to better study the conditions of the movements produced by parts of a galvanic circuit in loose contact, Mousson employed an instrument by means of which the pressure of the contact could be varied. The "restoring force which in the rocking bar is its weight" is here replaced by the "torsional elasticity of a metal wire secured at its lower end and stretched by means of a screw at its upper end. A small plate fixed at the middle of the length of the wire carries two platinum knife edges, which run parallel to the wire, and are brought close together and bear upon a clock bell (small gong). The current passes to the gong through the wire and contact points, and the tension of the spring and the pressure are easily regulated in order to produce continuous vibrations, which acquire considerable force if they are in accordance with one of the sounds of the gong." Mousson here describes the results which follow when the pressure between the contact points is varied. He says that when the pressure is at zero the mechanical and galvanic contact is interrupted, no current passes, and the needle of the galvanometer does not move. When a slight pressure is applied a mechanical contact takes place, but the galvanometer needle still remains at rest, because the galvanic contact is not yet established. This curious fact can no doubt be attributed to the *presence of a layer of condensed air*, which exists on the surface of all solid bodies, and which by resisting a slight pressure prevents metallic contact. When a greater pressure is applied it causes a mechanical and galvanic contact, but *it is always inconstant.* The needle oscillates constantly with greater or less force and is never in a state of repose. At the same time a slight hissing is heard like the long-continued sound of the consonant S. The current passes, but it constantly modifies the contact and the resistance presented by the same. Mousson attributes the change of resistance to calorific effects at the contact points, and says that the "variations of contact are produced without interruption of the current.

An illustration of Prof. Mousson's instrument as above desbribed, is found in his work "Die Physik auf Grundlaye der Erfahrung," Zurich, 1874, vol. 3, page 412, fig. 942. The article relating to "movements produced by parts in light contact," describes the instrument as follows, viz., "The torsional elasticity of a strong wire, A, as shown in fig. 942, serves to hold contacts together. The wire is provided at the middle with an arm, B, clamped to the wire, and provided with two knife edges of platinum, which latter are held against a harmonic bell, C, conforming to the vibrations of the wire. When the current enters the bell at *a*, and passes out through the bell shank, light vibrations are caused by the agitation of the lever, which are reinforced by the bell, and are heard as a clear tone of considerable loudness.



I think it is almost needless to add that Prof. Mousson's instrument, as above described and illustrated, becomes a veritable microphone when "spoken to," and will transmit speech when used in connection with a telephone receiver. To show how carefully he studied the phenomena that are supposed to take place at variable contact electrodes, it is only necessary to say that Mr. Berliner, and others, have attributed the action of the microphone to the action of a "layer of condensed gas between the electrodes." Mousson, it will be seen, makes mention of this phenomenon. Then, again, transmitting-telephones have been constructed where the electrodes are held in contact by a torsion spring, very much as in the Mousson instrument.

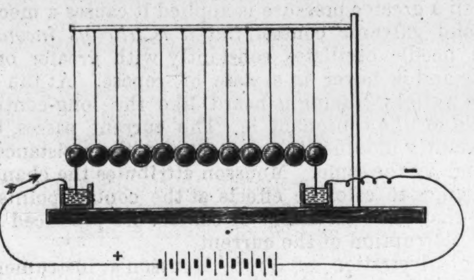
I now call attention to other references which disclose instruments that have a close bearing upon certain special types of microphones. It is undoubtedly well-known to those conversant with the history of the microphone, as disclosed by text-books, that the microphone of Boudet de Paris has a series of carbon balls placed in a glass tube, and which operate by impact, as "in the billiard ball experiment."

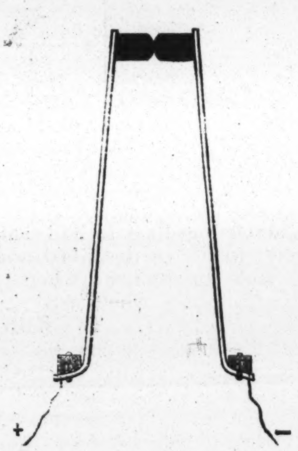
The French journal *Cosmos*, for 1858, vol. xiii., p. 148, has an article by Van Breda and Lorgeman intended to prove Ampère's law of repulsion. They state that "in carrying out their experiment they employed 12 iron balls, of some 8 to 9 millimetres in diameter, suspended as the billiard balls in the experiment on the impact of bodies, the centres of the ball being in line with each other. The two end balls have points which dip into mercury cups that are in communication with the poles of a battery of 12 Grove elements. When the current is made to traverse the balls the two end balls are repelled from the others about one millimetre, and sparks are observed between each pair of balls.”

---

* These experiments and others were described in my previous articles.

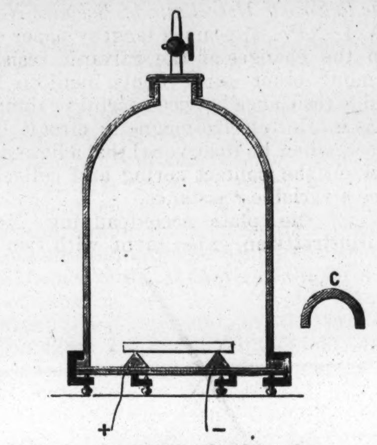
Wiedemann, in his work “Die Lehre der Electricität,” in referring to this last described experiment, which may be illustrated by the accompanying sketch, says that the passage of the current through the balls is attended by variations in its flow, according to the degree of contact of the balls and the calorific effects between the same. Wiedemann also states that the formation of sparks and the voltaic arc, together with the expansion of the electrodes by the calorific action of the current, can give rise to a vibratory movement of the electrodes between which such actions take place. If two carbon points are fastened to two elastic wires which by their pressure hold the electrodes together horizontally, then when the electric circuit is closed, a “clattering” noise like a series of small explosions is heard, and the passage of sparks and the formation of the electric arc between the electrodes is heard. The vibrations produced in this manner are imparted to the wires, and can be viewed, and felt by the fingers.





Mr. Berliner and others, in order to disprove the theory that the microphonic action is produced by a film of rarefied or heated air between the electrodes, placed the latter in a vacuum chamber. It is not necessary for me to describe the result of these experiments; but in this connection I call attention to the experiments of Reitlinger, described in the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna, A.D. 1862, page 453. The article is entitled “Tones and some Phenomena of Motion Produced in the Closed Circuit of a Galvanic Current.” After reviewing the experiments of Paalzow, Forbes, Gore, and others,* and stating that the electrode of an electrical Trevelyan instrument will rock under water, he describes certain experiments performed in a vacuum chamber with a sheet iron semi-cylindrical rocker resting upon knife-edge bearers. The experiment can be illustrated by the following sketch.

In this experiment it was not necessary to start the rocking motion by an impulse, the electric current passing across the contact points, produced the rocking motion. Reitlinger, like others before him, attributed the rocking motion to electro-dynamic repulsion, and to disprove the “heated air” theory, he performed the operation in a vacuum. The close analogy to microphone contacts in a vacuum is apparent.



C, cross-section, sheet iron rocker.

In Poggendorff’s *Annalen der Chemie and Physik*, vol. 124, A.D. 1865, Buff describes his experiments on the production of sound by electricity. After referring to prior experiments of Poggendorff, who placed a sheet metal tube, slit lengthwise, around an electro-magnet, and produced tones in the metal cylinder when the edges of the slit were in incomplete contact, and an interrupted current was passed through the electro-magnet. Buff describes his own experiments, which I have illustrated by the sketches below.

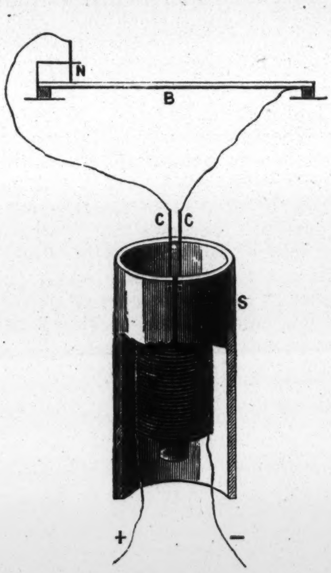


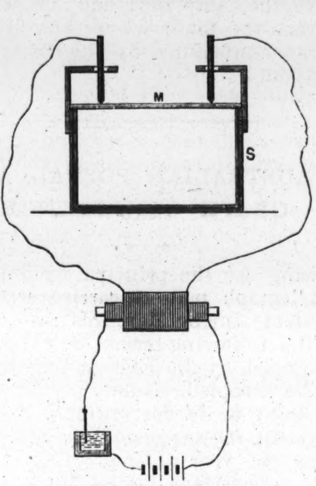
FIG. 1.

N, needle; B, brass plate; C, C, copper wire; S, sheet metal tube slit lengthwise.

In sketch fig. 1. the slit sheet metal cylinder of Poggendorf is used as a transmitter, in which currents are induced by an interior electro-magnet, through which intermittent currents are passed. The receiving instrument is a brass plate, upon which rests a needle electrode that will set the plate in vibration. It is stated that the cause of this vibration is due to “the incomplete contact and consequent increase of resistance at the contact points between the needle and the plate.” It is also stated that “when the point of incomplete contact is made of a piece of fine platinum wire, or fine sewing needle, whose *slightly oxidised* point rests upon the plate, then with a current of suitable strength, the point is heated to incandescence, and then when the current is not too rapidly interrupted a perceptible variation of the incandescence phenomena at the contact points is observed. It is apparent that similar variations, although not visible to the eye, are present when the contact points are not heated so much. If this theory is accepted then the sound produced is due to heat effects at the contact points." Referring to Buff sketch fig. 2, the description which warrants the same states that a metal plate rests upon a sounding box, and that two needle electrodes bear loosely upon said plate and are connected with the secondary circuit of an induction coil. The primary circuit of this coil contains a circuit breaker which may be either a rotary "make and break," or a mercury cup in which a wire is immersed that is drawn out to break the circuit. In this connection and as having a very pertinent bearing upon the question, as to whether the arrangement with a mercury circuit breaker will not produce a practically continuous induced current, I cite the "Archives de l'Electricite," vol. 5, A.D. 1845, p. 222, in which De La Rive in his article on the production of musical sounds by intermittent currents, says: "A mercury rheotome produces more sustained sounds and slighter shocks, since by the same the interruption of the current is more gradual and not sudden as with a toothed wheel, this being due to the fact that the slight amount of mercury which always adheres to and goes out with the needle when the latter is drawn out of the mercury." In this connection I also cite "Etude sur la Téléphonie," by Dr. Rothen, Berne, 1884, page 93, where Prof. Hughes is quoted as saying that in the reversibility of the microphone (as receiver) the vibration of the diaphragm is in consequence of the variations of the temperature at the point of contact, and that the expansion and recession of the material (contact) produces blows against the diaphragm, and hence causes the same to vibrate. Those who are familiar with the French microphone of Pollard and Garnier, will readily perceive that the "microphone receiver" of Buff closely resembles the same, since both have sliding rod shaped electrodes resting loosely upon a diaphragm. Before closing my review of references which, in my opinion, deprive the *instrumentalities* used in the modern microphone almost, if not entirely, of all novelty, I wish to call attention to a newly published fact that I have discovered concerning the Reis telephone. In the *Annales Telegraphiques*, Vol. VII., A.D. 1864, page 592, it is stated that "the telephone of Reis would be an admirable instrument if it realised in a perfect manner the hopes of the theory. Without prejudging the future, it is well to recognise that it is not yet perfect. When the gamut is produced at the transmitter it takes a well trained ear in order to recognise the sounds in the midst of the vibrations (tremblements) to which it is subjected. Besides this, the model instrument of which we speak is exposed to several causes of error, since the membrane will, at certain moments, not vibrate with the same amplitude, thus occasioning at times want of contact. If the sound emitted rests *within* neighbouring limits *the contact is prolonged.* This inconvenience is avoided by substituting for the voice of the operator a tuning fork furnished with a vibrator (systeme trembleur), then the note is more precise, although always very weak.

---

* Reviewed in my former articles.—A. M. T.



M, metal plate; S, sounding box.

FIG. 2.

It is not my intention to detract from the merit of the discovery that the loose contact electrodes of Mousson, Rollman, and others, can be set into vibration by the human voice, and thus used for the transmission of speech, the object of the present article being mainly to show that almost all the theories advanced concerning the operation of microphonic contacts were known many years ago, and, as at present, there were men at that time adherents of the "repulsion," "heated air," "arc," and "condensed air" theories. As I stated at the commencement of my present article, the microphone did not require the discovery of the principle that light electrodes placed in loose contact will, by a change of position, or the diminution and increase of the contact surfaces, serve to effect a change in the tension of a current flowing across said contacts. This phenomena was carefully studied by Prof. Mousson, and it only remained for Prof. Hughes to select a known form of variable contact rheostat, just as Bell and Gray used a liquid rheostat in their original experiments. A mercury rheostat, it may be added, was also used in Prof. Mousson's experiments, and he considered the same the equivalent of solid metal bodies placed in loose contact one upon the other.

ELECTRIC LIGHTING IN MINES AND DAMP SITUATIONS.

WITH the object of overcoming the difficulties which are met with in preserving the insulation at switches, cut-outs, or lamps in the tunnels and workings of mines, Mr. R. Oliver G. Drummond, electrical engineer to The De Beer's Consolidated Mines, Limited, of Kimberley, South Africa, has designed the following fittings :—

The switches* (fig. 1) and fuses are mounted on specially designed bases, insulated from the bolt that secures them to the timber or roof, and fitted with a cover to keep off the dust, &c., and to protect the workmen from shocks. The wires are drawn in from the

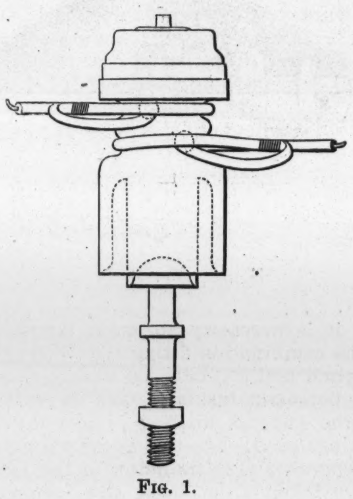


FIG. 1.

---

* The arrangement of the switch seems liable to allow dripping moisture to percolate between the switch turn and the opening in the cover through which it passes.—EDS. ELEC. REV.

lower side of the base, and consequently the dripping water cannot run up the lead into the switch or the fuse. With these fittings there cannot be any appreciable leakage, except where there is a large amount of moisture in the air and consequent condensation on the sides of the insulated bases.

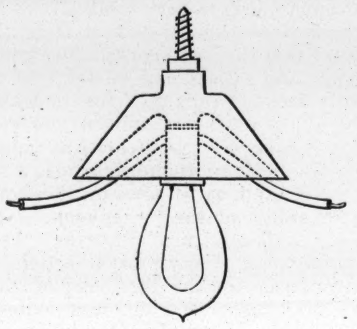


FIG. 2.

The lamps are suspended from a holder (fig. 2) fitted inside a porcelain insulator, which is of such a shape that it becomes a reflector to the lamp, throwing the light downwards, and the heat of the lamp rising into this insulator keeps it warm and dry, no matter how full of moisture the air is. Any water dripping on to it from the roof runs off the outside of it, so that the lamps and holders are thoroughly insulated; and faults from bad insulation are impossible. The bracket lamp is designed of a shape suitable for fixing to the sides of the tunnel, and is fitted in an insulator with the same results as the hanging lamp. The reflector in this case is of such a shape that the light is thrown upwards, downwards, and sideways.

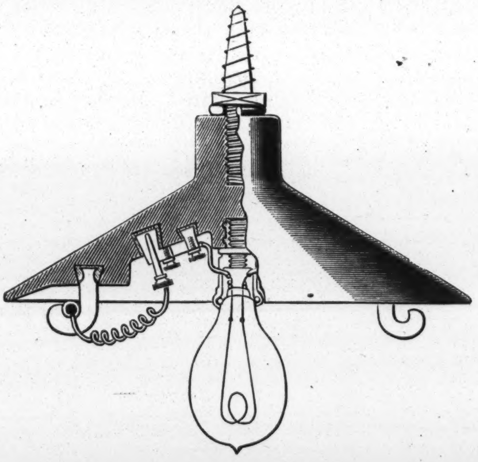


FIG. 3.

When it is necessary to hang lamps in very wet places, the combination fitting (fig. 3) is recommended, as the switch and cut-outs are arranged inside the reflector or porcelain insulator, and as will be seen the heat of the lamp is utilised to keep the insulation of these fittings good. The two hooks are used to suspend the conductors, and as the joint for the branches to the lamps are taken from here, the insulation of these joints is kept good by the warm air rising from the lamp. This fitting has many advantages in rock tunnels, or places where it is necessary to suspend the wires from the roof by insulators, and where there is no timber to attach the wires, lamps, cut-outs, or switches to, and consequently holes have to be bored in the rock, and wooden plugs driven in them. In these tunnels it is generally expensive to bore holes in the roof, as the rock is very hard, and the required position of the holes is the most difficult for boring, so that the less there are the better. For these reasons the combination fitting was arranged to carry as much as possible. It takes the place of a bracket for two insulators, a support of one switch, two cut-outs, and a lamp-holder, thus one hole suffices for five. The fitting is, moreover, very efficient, as the heat of the lamp is utilised to keep all the necessary parts in connection with the lamp dry, and also the joints and branches from the main wire. The fittings, we may mention, are manufactured by The Electrical Engineering Corporation.

SOUTH AUSTRALIAN POSTAL AND TELEGRAPH CONFERENCE.

THE following are the principal resolutions, with reference to telegraph matters, carried at the conference held in Adelaide during May, 1890:—

1. That the following terms for reduction of cable rates, as proposed by the Eastern Extension Telegraph Company, be accepted, namely:—"Firstly, the tariff will be reduced to 4s. for ordinary messages, 3s. 6d. for Government messages, and 1s. 10d. for press messages during one year of trial. If at the end of the first year no very serious loss is involved, the experiment will be continued for two years more, and such extension must be at the option of the company. If the loss should be nearly recovered at the end of the three years, the arrangement will be extended for the remainder of the subsidy. The whole proposal is conditional upon South Australia accepting 5d.—the transit rate." (Queensland dissented.)

"2. That in the event of South Australia reducing the telegraph rates on the trans-continental line, in accordance with any resolution agreed to by this conference, the several colonies represented at this conference, including South Australia, agree on the basis of population to guarantee to South Australia a revenue from the line equivalent to that received at present." (Queensland dissented.)

"3. That any colony or country not joining in the contribution to subsidy and guarantee, shall pay proportionately higher rates."

"4. That it be a recommendation to the various Governments represented at this conference. 1. That between any two contiguous colonies 1s. shall be the initial charge for twelve words, and 1½d. for each additional word; names and addresses to be paid for. 2. Between any three colonies 1s. 6d. to be the minimum charge for twelve words, and 2d. for each additional word. 3. Between Queensland and Western Australia 2s. to be the minimum charge for twelve words, and 3d. for every extra word. 4. Tasmania to be a minimum rate of 6d. for twelve words for each colony, plus the cable rates. Twelve words to be considered the minimum rate. Addresses and signatures to be paid for, and code addresses to be prohibited. 5. That the reduced rates come into operation on January 1st, 1891."

"5. That it is considered desirable to adopt a system of urgent telegrams, at double rates, locally and intercolonially."

"6. That the Uniform Intercolonial Telegraph Regulations, as drawn by heads of departments, be adopted."

"7. That in the opinion of this conference it is very desirable that the heads of the Post and Telegraph Departments of the Australian colonies should frequently meet—annually, if possible—to consider and report to their respective Governments on all questions affecting the postal and telegraphic services generally."

"8. That the President forward to His Excellency the Governor of South Australia a copy of the resolutions agreed to by the conference regarding the reduction of postal and cable rates to the United Kingdom, requesting that his Excellency will forward it to the

British Government by cable, with the expression of the earnest desire of this conference that, as England is equally interested with the colonies in securing and maintaining cheap telegraphic communication, the proposal of the conference that Great Britain should contribute towards the subsidies and guarantees required may be accepted by the Imperial Government."

"9. That the President inform the Agent-General of South Australia of the acceptance by the conference of the amended offer of the Eastern Extension Cable Company, and request him to confer with the Agents-General of the several colonies represented at this conference in order that they may jointly urge upon the Imperial Government their acceptance of the proposal that England should contribute one-half of the susidies and guarantees required in order to secure the reduced rates agreed to for telegraphic communication between England and the colonies of Australasia."

The colonies represented at the conference were New South Wales, Victoria, South Australia, Queensland, and Tasmania.

SOME NOTES ON GUTTA-PERCHA.

THE *Annales Télégraphiques* in its September-October issue, contains an interesting communication on the gutta-percha tree. We reproduce some portion of this article.

The word *gutta* (*guetah* or *gueutta*) in the Malayan language means, in a general sense, gum or birdlime, something sticky. The word *pertcha* or *perfia* means a rag or a strip of cloth, and describes accurately enough the appearance of those gums which, previous to their treatment in hot water, are not unlike rags pressed, and in a partly pasty condition. The idea that *pertcha* or *perfia* signified *Sumatra* is an error participated in, till lately, by all travellers.

The existence of gutta-percha was made known to the civilised world in 1842 by Montgomerie, the claims of the explorer Tradescant to priority of discovery not being established. The first specimens were brought to London from Singapore in 1843 by José d'Almeida, and the remarkable properties of these gums were speedily made known by Hancock. To Wheatstone must be given the credit of seeking to employ gutta-percha in the insulation of telegraph conductors, but Walker in 1849 in the Channel cable first attempted a practical application.

Since that date many experiments have been made with the view of discovering a substitute for gutta-percha, which is daily becoming more difficult to find, and more costly; in submarine telegraphy the best quality can only be employed, and all attempts up to the present have failed to replace it. The gum of the African *Bassia Parkii* and of the Guiana *Mimusops Balata* have only given negative results; as to the *Payena Leerii* it is used, and to a considerable extent, for the adulteration, in the forests, of the better gums.

The only gums which are suitable for use as insulating material in submarine cables are obtained from the trees of the species *Isonandra.* These plants, which are treated by many botanists as belonging to the species *Palaquium* or *Dichopsis* in the desire to establish a finer distinction, have their natural and exclusive habitat in the Malay archipelago. The extirpation of this species in Malaysian forests proceeds with rapid strides; the natives in cutting down every tree at all productive, and pursuing the same course with the second growth, that is to say, preventing the plants from attaining their full development, have during the last 40 years completely destroyed any possibility of reproduction and multiplication.

The gums, such as were employed in early days for industrial purposes, are now only found occasionally; those which have replaced them will follow the same fate before another 15 years have elapsed. Exportations from Malaysian ports are rapidly diminishing. The inadequate plantations created in the Dutch East Indies are principally composed, not of the better classes, but of those producing the most abundant sap, that is to say, of inferior varieties. Submarine telegraphy is on the point of finding itself deprived of the species indispensable to it in its operations and extensions.

In chronological order the plant first made known as being the source of a gutta-percha was the *Isonandra Gutta* of Hooker. This tree, the only one whose coagulated sap (sent to Europe at the same time as were the specimens of the plant) has met with practical success, has remained but imperfectly described. It is treated as a species extinct, since 1857, in the island of Singapore, and as existing only in Malaysian forests. As a matter of fact, it has become exceedingly rare, but it is yet to be met with; its fully grown representatives were still to be found in 1887 on the Chasseriau Estate situated in the ancient forest of Boukett Timah (hill of tin) in the centre of Singapore, where the tree was discovered by the botanist Thomas Lobb in 1847. When the plant was again met with in Singapore in 1887, all collecting had there ceased for at least 30 years.

This *Isonandra*, known as the *Isonandra Gutta* of Hooker, the *Dichopsis Gutta* of Bentham and Hooker, and the *Palaquium Gutta* of Baillon, arrives at maturity at the age of 30 years. Its trunk has then a height of from 40 to 44 feet to the lowermost branches, it is cylindrical in shape, and has a circumference of about 3 feet at a height of from 3 to 6 feet from the ground. It flowers every two years after the age of 30. The shape and size of the leaves of the *Isonandra* vary so much, according to the age of the tree and the situation of the leaf, that some confusion has been created in the case of many specimens which have been wrongly assigned to different varieties.

In the Malaysian forests there are only five trees which can be confounded with the *Isonandra Gutta*, partly owing to a kindred foliage, but to a greater degree from the similarity of the saps. No confusion is possible with the other *Isonandra*, which are themselves separated by the *Payera Leerii* (gutta seundek). The guttas seundek, as known in commerce, are nothing but complex mixtures.

The author of the article, M. Sérullas, differs in some measure from the conclusions arrived at by M. Seligman-Lui, who it will be remembered visited the percha producing districts of the Eastern Coast of Sumatra, in 1881, on behalf of the French Government. The Payena Leerii is quoted by M. Seligman as possessing most valuable properties, whereas M. Sérullas distinctly qualifies it as an inferior variety. The practical value of the Dutch plantations at Buitzenborg (Java) also forms a point of difference; M. Seligman not only attaches great importance to the probable results of this experimental cultivation, but actually describes the operations as being very successful, and the method most efficient.

THE ARGENTINE-EUROPEAN CABLES.

THE Buenos Ayres press has been of late engaged in a controversy as to the merits and defects of the concession granted to Messrs. Bieckert & Co. for a direct cable between the River Plate and Europe.

It was rumoured, not long since, that the present Government of the Argentine Republic had decided to annul the concession, but more recently it is announced that this statement was incorrect, inasmuch as the concession has been ratified by President Pelligrini and General Racas.

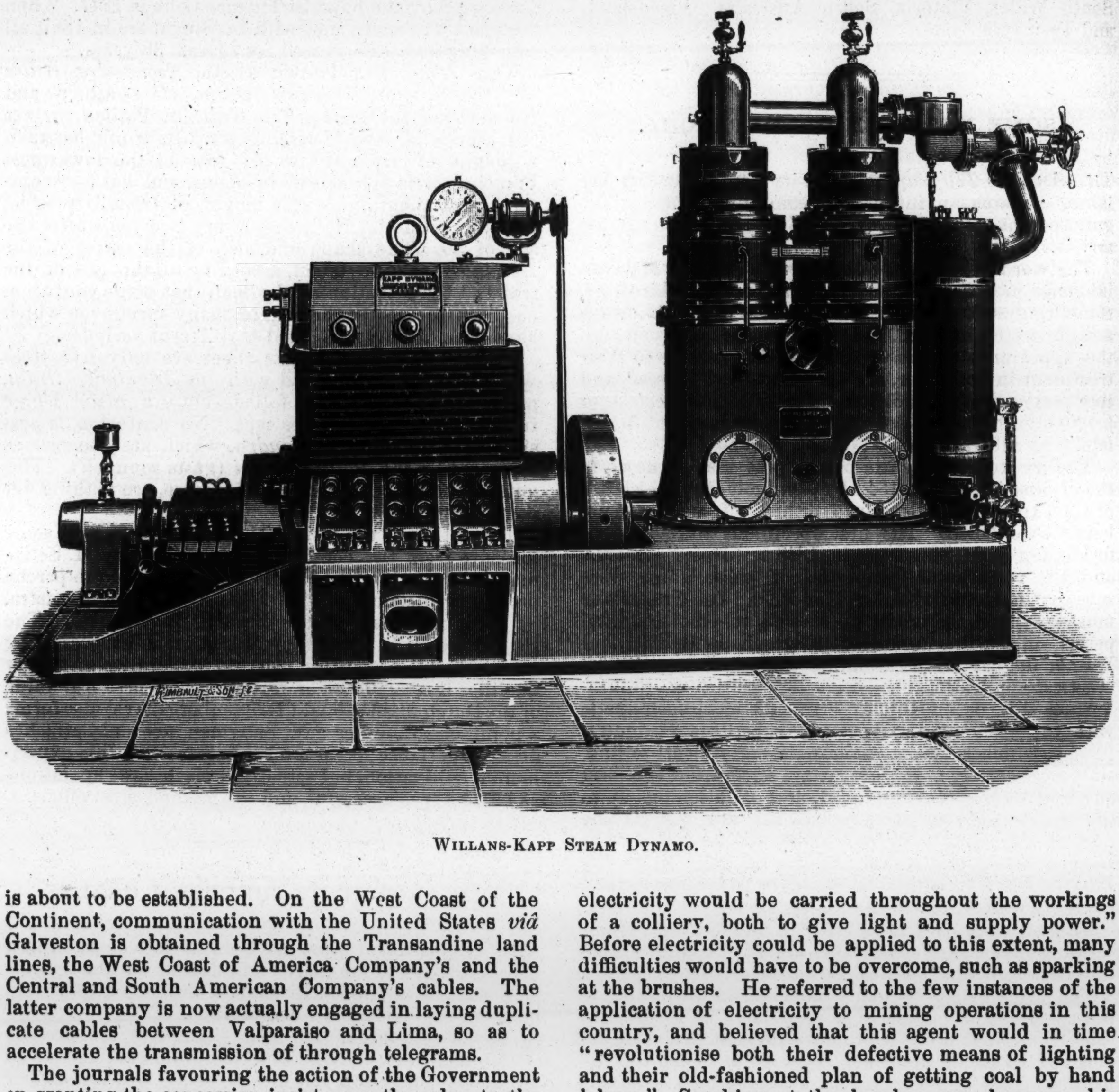
The journals unfavourable to the concession point out that the nation, whose finances are in anything but a flourishing condition, lays upon itself the burden of having to pay a guarantee of 5 per cent., for 20 years, on a capital of 11,000,000 gold dollars, and they draw the attention of their readers to the fact that another association of capitalists had made an unsuccessful attempt to obtain the guarantee of 5 per cent., for 10 years only, and on a capital of only 9,000,000 gold dollars. For this reason, and also on account of the rumours and suspicions current as to the part played in the transactions by certain high functionaries, it would have been more seemly, say these journals, had the Government entered into a careful investigation of the circumstances under which the concession was originally granted.

Attention is also called, as a motive for deprecating any assistance on the part of the Government towards the laying of new cables, to the very ample telegraphic communication existing between the River Plate and Europe, more than sufficient, indeed, for the requirements of the country. On the east coast of South America, in addition to the cables of the Western and Brazilian Company, which it is expected will be shortly duplicated, two land lines connect Monte Video with Pernambuco. This point is joined to Europe by the Brazilian Submarine Company's cables, and another cable route *viâ* the West Indies and the United States, is about to be established. On the West Coast of the Continent, communication with the United States *viâ* Galveston is obtained through the Transandine land lines, the West Coast of America Company's and the Central and South American Company's cables. The latter company is now actually engaged in laying duplicate cables between Valparaiso and Lima, so as to accelerate the transmission of through telegrams.

The journals favouring the action of the Government in granting the concession insist upon the value to the Argentine Republic of an independent and direct communication with Europe at a low tariff. Such a scheme would possess the additional advantage of avoiding the territories now connected by the existing system. At the present tariffs, it is intimated that there is an annual exchange of over a million words between the Argentine Republic and Europe, and it is calculated that the low tariffs to be charged on the new cable will materially increase this quantity. To lend the scheme a more captivating appearance, the dividends paid by the Brazilian Submarine Company during the last few years are quoted as follow: 1881 to 1882, 7 per cent.; 1882 to 1886, 6 per cent.; 1886 to 1888, 7 per cent.; and 1888 to 1889, 7½ per cent.

ELECTRICITY AND MINING.

IN the course of his inaugural address—on coal mining—delivered before the Manchester Geological Society last week, Mr. J. S. Burrows, F.G.S., referred to the subject of the lighting of mines. He had but little to say regarding the electric lighting of mines beyond the use of primary and secondary battery lamps, neither of which he at present considered to be a success. The President's address was followed by a speech made by Mr. Merivale, who could "conceive of a time when electricity would be carried throughout the workings of a colliery, both to give light and supply power." Before electricity could be applied to this extent, many difficulties would have to be overcome, such as sparking at the brushes. He referred to the few instances of the application of electricity to mining operations in this country, and believed that this agent would in time "revolutionise both their defective means of lighting and their old-fashioned plan of getting coal by hand labour." Sparking at the brushes was, however, his bugbear; but this difficulty, as is well known, has already been overcome in many machines on the market, whether running at full or less than full load.



WILLANS-KAPP STEAM DYNAMO.

The dual subject raised by the two speakers is one which is gradually being brought into greater prominence among mining engineers and mine owners in this country. Portable electric lamps of the primary and secondary battery types will probably come into use in time, but owing to their high price and inconvenience of recharging, it is fair to assume that they will not be extensively employed. It appears more probable that the electric lighting of mines will be conducted on similar principles to those adopted in private installation work, that is to say, the generating plant will be suitably installed and the lamps placed along the roadways, whilst portable lamps will be used where the leads have not to be carried. In this connection it is interesting to note that the Fife Coal Company have announced their intention of introducing the electric light in their pits at Leven, the lamps to be placed 15 yards apart along the roads.

The application of electricity for pumping and hauling purposes at St. John's Colliery, Normanton, in the Forest of Dean for pumping, at Llanerch Colliery for pumping and hauling, and at Linlithgow for pumping purposes, has shown by actual working results that electricity is more economical than compressed air or steam plant. Electric coal cutters were "demonstrated" some three or four years ago, but, beyond this, nothing seems to have been heard of these machines. We are informed, however, that an English firm has supplied electric coal cutters for nearly four years, and that the plant is running successfully. At present, details regarding these machines are for obvious reasons withheld, but practical working data will in the course of a few months be forthcoming, when the subject will be brought before the notice of the engineering world.

TRIALS OF A WILLANS-KAPP STEAM DYNAMO.

WE give the result of the economy trial of a Willans-Kapp steam dynamo which Messrs. Johnson and Philips have built for the Birmingham General Post Office.

[COPY.]

CONSUMPTION TRIAL.—NO. 982.

Engine. No. 982. For Birmingham P. O. Barometer 30·3 falling. Dy. No. 83. Date August 8th, 1890. Present, Mr. Low.

Water collected.				100 lbs. interval.		Ampères.	Vlts.	Remarks.
Weight in lbs.	Time.							
	hrs.	mins.	secs.	mins.	secs.			
4420	3	36	15		...	450	Volts constant at 112 throughout run.	
4520	3	39	34	3	19	452		Voltmeter. Evershed, 436, checked by small S. dynamo. Ammeter Siemens = 2177.
4620	3	43	53	3	19	440		
4720	3	46	13	3	20	448		
4820	3	49	34	3	21	454		
...		...			...	410		
5020	3	56	11	3	18·5 (2)	443		
5120	3	59	34	3	22	450		
5220	4	2	50	3	16	452		
...		...			...	448		
5420	4	9	31	3	20·5 (2)	450		
5520	4	13	46	3	15	456		
...		...			...	450		
5720	4	19	20	3	17 (2)	452		
...		...			...	438		
5920	4	26	9	3	39·5 (2)	438		
6020		...			...	440		
6120	4	32	49	3	20 (2)	450		
1700	0	56	34		...	...	...	
				Mean	...	447·2	112	Kilowatts 50·2

Indicated H.P. = 79·7. Electrical H.P. = 67·4. Commercial efficiency = 84·6 per cent. Total water per hour, including escape from jet cocks, 1,807 lbs. 27 lbs. of steam per E.H.P. hour.

New Electric Construction Works at Wolverhampton.—The new electrical construction works at Bushbury, on the north side of Wolverhampton, will be ready for occupation before Christmas, and will give employment to some 1,500 hands. The company has sufficient contracts on hand to keep the works in active operation for some time to come.

NOTES ON CENTRAL STATION ELECTRIC LIGHTING.*

By CHARLES H. YEAMAN, Assoc. Inst. E.E., Stud. Inst. C.E., City Electrical Engineer, Liverpool.

AT various times the industrial applications of electricity have occupied the attention of this Society; and of these, the most taking has without doubt been the calorific or thermal effects of the current practically used in the arc and incandescent lamps. In March, 1885, a paper was read on "Electric Lighting from Central Stations," drawing attention to the American and English stations then supplying current, and blaming the Electric Lighting Act of 1882 for the tardy development of the heavy electrical industries, and more especially that of the public supply of electricity.

Since the date of that paper, the Amendment Act of 1888 has been passed, and the first fruits of its lightening of the burdens borne by the craft of electrical engineers are to be seen far and wide. The difficulties which had previously beset the use of electricity in this country had taken the shapes of mad speculation and legislative restriction. The lessening of these difficulties has removed most of the impediments to the extension of electrical works. That this is the case, is proved by the number of central stations projected and in use all over the kingdom, in connection with schemes which have sprung into being since the passing of the 1888 Act. The present position of the industry, technically, is one of friendly antagonism between the devotees of some half-dozen systems, any one of which would probably, in competent and experienced hands, prove successful, and each has certain advantages and disadvantages compared with its rivals.

The problem of a commercial supply of electrical energy throughout an extended area directed attention to the question of the pressure or voltage to be employed. The lamps at present on the market do not allow of any very great choice in this respect, the lowest pressure for a 16 C.P. incandescent lamp being about 50 volts, and the highest a little more than double that value.

There are special types of lamps to be had of somewhat lower and higher voltages, but, generally, they do not give satisfaction; and, as standard pressures for the lamp circuits are generally adopted, and as the price of the lamp is its chief drawback, any great multplication of standards is to be deprecated. The Brush Company prefer 60 volts, Sir William Thomson advocates 80, The Metropolitan and London Electric Supply Companies and Messrs. Crompton usually specify 100, and here in Liverpool 110 volts is maintained on the canalisation. The Westinghouse Company, of America, have adopted 50 volts for their lamp circuits, and it is understood that the Sardinia Street Station of the Metropolitan Company, in London, run on this system, has also taken the American practice as its basis.

For isolated plants, where the dynamo was only, at the most, a few dozen yards from the lamps, a simple parallel low tension supply satisfied all requirements, and was both economical and sufficiently elastic in working to make any elaborate regulating arrangements unnecessary. As the distance to which the current had to be transmitted was increased, it was found that either the network of mains required to be large, unwieldy and costly; or that the loss in pressure was excessive, and that lamps of different voltages were required to compensate for the variations in voltage as the distance from the supply increased. On the simple tree system of working, it was impossible to keep within anything like the limits of the variation permissible by the Board of Trade Rules, and the system of feeders and feeding points, as proposed by Edison, was used where possible. On a low-tension network properly laid out, aided by feeders, it is commercially possible to work within a radius of a quarter of a mile from the station, and carry out all the regulations under law as to the maximum pressure and the allowable variation.

As at this point it might be expected something should be said regarding Liverpool electric lighting, the writer would only soothe the fears of those who dread shocks, by assuring them that there is, in the system at work in this city, no possibility of personal danger, and that the danger of fire has been very efficiently guarded against. As Messrs. Holmes & Vaudrey, the engineers of the company, are members of this society, it is not desirable to trench upon anything they might wish to say in the future about their own work, and as one can always gain information about the Liverpool work by personal enquiry, it is proposed to look further afield for stations to be discussed.

One of the first difficulties that the supply companies had to grapple with, was the small encouragement given them to lay underground mains, and they were compelled, if they intended to supply at all, to go overhead, so much were they opposed on attempting to break up the public streets. Of course it was quite out of the question to run heavy circuits of copper strap or large cable aerially, and some method had to be thought of, by which to supply customers at great distances, and with a fairly large quantity of the commodity called "Electricity," which, be it noted *en passant*, requires to be defined, if one is to use it generally. Electricity to the public means *energy*, to the technologist it denotes *current*, a very different thing. The thing the public want, and which they are quite willing to pay for, and handsomely too, is electrical energy; this is not simply current, but the value found by multiplying the numeric of the current by that of the pressure in case of a current flow in one direction or uni-ward, but which is, with alternating or periodic currents, equal to $\sqrt{f\,e^2} \times \sqrt{f\,c^2}\cos k^0$, the square root of the mean square of the electromotive force, multiplied by the square root of the mean square of the current, multiplied by the cosine of the angle of lag between the impressed E.M.F. and the resulting current.

---

* Paper read before the Liverpool Engineering Society, January 29th, 1890.

Since the aerial cables must be kept of moderate size, and it is well known that the carrying capacity of a cable is limited to a certain number of ampères, or a certain current, quite independent of the pressure under which that current flows, and the energy—that which is desired to be transmitted—is proportional to the product of the two factors, an attempt was made lately, and successfully, to increase the voltage under which the current flows, thus decreasing its volume with a given output of energy, and enabling a smaller size of cable or weight of copper to carry a supply of electrical energy a given distance with a given loss, than would be required with the pressure used up till that time. Regarding the loss in transmission, it must be remembered that the loss is a loss of head or pressure, and that it is analogous to that in a pipe, where the friction reduces the available head so many feet per hundred yards per rate of flow. The point where the analogy fails is the fact that friction has not a numeric as if it were a physical quantity like mass or specific heat. The question of high tension electric supply is very much like the problem solved by Mr. Ellington, in his power distribution scheme by high pressure water. Since by doubling the pressure we quarter the area of the conductor, or what is the same thing, reduce its weight per unit length to one-fourth, it will be seen that with a given loss *per cent.*, the weight of copper required to transmit a given quantity of energy, a given length is inversely as the square of the volts employed. That this is so may be easily seen, if it be kept in mind that the loss in distribution is proportional to the current density in the conductor. Let C represent the current and E the voltage at which that current is to be distributed, then $C \times E$ represents the total energy; and, if R be the resistance of the copper core, the loss will be $C^2 R$ watts; therefore, the percentage loss will be

$$\frac{C^2 R}{C \times E} \times 100$$

If $C E$ watts be distributed at double the first pressure, or $2 E$; the current will be reduced to $\frac{C}{2}$; and, if the loss is to remain at its previous value, $C^2 R$ must now be $(\frac{C}{2})^2 4 R$, and the percentage loss becomes

$$\frac{(\frac{C}{2})^2 4 R}{C \times E} \times 100 ; \textit{i.e.,}$$

the weight of copper required has been reduced to one-fourth, with the same loss. Therefore, with overhead conductors, two things are gained by using high tension. (1.) A lighter conductor to transmit a given quantity of energy; and, (2.) A smaller per cent. loss with given density of current.

As has already been pointed out, high pressure cannot exist across the terminals of a lamp, and therefore some appliance, called a transformer, secondary generator, or converter, must be inserted to deliver the energy of the high tension electric supply to the lamp at the voltage for which it is intended. The general theoretical law of these transformers may be thus expressed:—

let e = Primary H.T. E.M.F. in volts.
c = „ „ Current in ampères.
E = Secondary L.T., E.M.F. in volts.
C = „ „ Current in ampères.

then $e\,c = E\,C$, or the energy of the two sides of the apparatus should numerically equate. This it never does, but the efficiency or

$$\frac{\text{energy got out}}{\text{energy put in}} \ \textit{i.e.,} \left(\frac{E \times C}{e \times c}\right) \times 100, \text{ may } \textit{at full load} \text{ be } 95.$$

In Mr. Vaudrey's paper, read before this Society in 1887, the question of electrical energy and its factors is fully dealt with.

The relative values of the two factors, the product of which, multiplied by time, gives the work done, may be varied as desired, and herein lies the beauty of all transforming systems. The primary circuit may be common to several transformers, and yet the secondary circuits may give any voltage, and any current desired; in fact, they may even work at a greater *power* than the primary circuit possesses.

The power of an electric circuit is expressed in watts, and the watts = energy expressed mechanically, or $C \times E$. The work = $C \times E \times$ time.

The principal disadvantages of transforming systems are—

(1.) Low percentage duty.

$$\text{Per cent. duty} = \frac{C \times E \times \text{time}}{c \times e \times \text{time}} \times 100$$

(2.) Low percentage efficiency at low power, *i.e.*, when not up to full load.

$$\text{Per cent. efficiency} = \frac{\text{watts got out}}{\text{watts put in}} \times 100$$

$$\text{or} = \frac{C \times E}{c \times e} \times 100$$

(3.) The high tension is dangerous to life. There can be no gainsaying the fact that personal safety *is* jeopardised by *excessive* pressure. There is the greater tendency to leakage to earth, and its attendant difficulties and dangers which are clearly foreshadowed in the Board of Trade regulations.

(4.) There is the dependance of a sub-district or area of lighting on a single piece of apparatus, and the insertion of another chance of failure between the dynamo and the lamps.

The transformers may be of various kinds.

A. Continuous current transformers.
B. Alternating current transformers.
1. Storage or battery transformers.
2. Non-storage or magnetic transformers.

These latter may again be divided into—

a Moving or dynamotors.
b Fixed or molecular.

All of the 1 class are at present A. All of the B class are at present *b*, those of *a* type have not found much favour, and are used principally in conjunction with those of class 1: they are therefore continuous.

The alternating current molecular transformer has by far the most extended application at the present time, and if the balance sheets of the stations under that system will bear perusal, it bids fair to hold its own with all the other systems combined.

To obtain the advantage of high pressure, transformers may be coupled in two ways like other electrical apparatus:—

C. In series, like arc lamps, constant current system;
D. In parallel, like glow lamps, constant potential system.

Alternating molecular transformers are usually coupled. D system and battery or chemical transformers in the C system. This is based upon reasons of simplicity rather than anything else, as it is a simple matter to obtain a constant current continuous, but hardly possible alternating, and because the effect of induction does not militate against a single wire carrying a continuous current, but a single wire through which an alternating current was flowing, would render telegraphy and telephony almost impossible for some distance around.

The cost of the generators in the two transformer systems is about the same, and any possible difference in this item will have but a very small effect on the total cost, of which it becomes a very small factor. The low pressure of the ordinary parallel system, the perfect protection from excessive current obtained by the safety devices in use, and the continuous character of its current, render it practically inert so far as its effect upon existing property is concerned. That the alternating system, with its strong inductive influence, will occasionally cause trouble to existing telegraph and especially telephone lines, seems inevitable.

The chief advantage with the battery transformer system is, that it is possible to spread the work of the engines over as long a period, within the 24 hours, as may be found convenient, so as at all times to work the engines at full power. When, on the other hand, the supply is taken direct from the machines, the engines must, at each moment, develop whatever power may be then under demand. It is well known that, with modern compound or triple-expansion engines, such as could be most advantageously used for central station work, the coal consumption rises very rapidly per indicated horse-power, as the output is diminished. This becomes a most serious consideration, when the maximum demand bears an undue relation to the mean. In many cases the maximum demand is five or six times the mean daily average, and lasts only half an hour or so.

Methods adopted in central station lighting:—

1. Series system with battery transformers. Example: Chelsea.
2. Series-parallel system. Example: Hastings.
3. Three wire system. Example: St. James's and Pall Mall, London.
4. Parallel system with batteries. Example: Kensington Court.
5. Alternating transformer system. Examples: West Brompton—Lowrie Hall system. Glasgow—Ferranti system. Bournemouth—Mordey system.

1.—SERIES SYSTEM WITH BATTERY TRANSFORMERS.

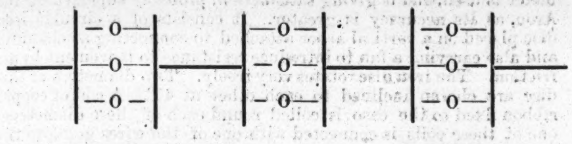
Example: Chelsea.

Following the order of the list of stations, Chelsea, with its stations for generating and distributing on the "King" system, first demands attention. The whole of the regulating and supply mechanism is automatic, the changing of the various battery stations in series alone being dependent on human energy and foresight, the system is extremely simple to work, but very complicated in erection, and it is doubtful if such a mass of interlocked automatic appliances is desirable, or if its life will be what is fondly hoped for. The system is an elaboration of the Beeman, Taylor and King station, which was laid down in Colchester in 1884, and of which a full account is contained in Mr. Fleming's paper of March, 1885, so that the description need not be repeated. The present plant, generating and distributing, and method of working, has been made public in a very complete and valuable paper, read by Major-General Webber, before the Newcastle-on-Tyne meeting of the British Association, in September of last year, and as nothing in the space available here could do justice to the subject, the writer begs to refer those interested to that paper.

2.—SERIES-PARALLEL SYSTEM.

Example: Hastings.

The use of transformers in a high tension circuit is to allow of flexibility and remove any restrictions to supply that otherwise would be imposed on the consumer. Hastings is an example of a high tension system without transformers, which has been working most successfully since 1881, and is now supplying over 1,000 incandescent lamps of 8 C.P. and 30 volts, the lamps being grouped in parallels of 16. This station, prior to the introduction of transformers, constituted the most successful instance of long distance distribution, not merely in this country, but anywhere. Brighton started also as a series-parallel supply, but has lately been altered to Lowrie Hall alternators. The principal feature which strikes one at Hastings is the extreme simplicity of the generating plant. The motive power consists of two 40 H.P. Robey engines and boilers, the engines being belted on to a counter-shaft rather below the level of the dynamo platform, and from which the five "Brush" constant current dynamos are driven by endless belts. These machines give 2,000 volts and 10 ampères. One is reserved as a standby, one is used for the arc lamps on the parade, the 30 arcs of 2,000 C.P. loading the machine fairly well up. The glow lamps are used in hotels and private residences, and these machines are run on the same number of separate circuits. The current flowing is proportional to that required by each lamp, multiplied by the number of lamps in parallel, and the pressure is equal to that required by one lamp, multiplied by the number of groups in series.



C = Current for one lamp.
E = E.M.F. " "
N = Number of lamps in parallel.
M = " groups in series.

E = E M.
C = C N.
C = Total E.M.F.
E = Total current.

The principal objection to a constant current supply is the fact that individual lamps of a group are dependent on their neighbours of the group, and no economy results unless the group of 16 lamps are turned off.

There are in Hastings underground circuits aggregating 20 miles of single wire, $\frac{7}{16}$ strand, double G.P. and braided, drawn into 4-inch cast-iron pipes, with test boxes every 100 yards. The terminal pressure of the dynamo is regulated by a Brush carbon regulator, which maintains the current constant at 10 ampères, and in the supply circuit is placed an Ayrton and Perry ammeter. The general method is to make a fixed charge per annum, which is settled by agreement.

The machines at Hastings are simple arc lighters, and give a current of 10 ampères suitable for arc lamps; they are used for incandescent lighting by grouping a number of incandescent lamps in parallel, so that they absorb the 10 ampères, and these groups are then treated as single arcs might be by being placed in series, *i.e.*, one after the other.

3. THREE-WIRE SYSTEM. PARALLEL SERIES.

Example: St. James and Pall Mall, London.

The three-wire system is one attempting to do away with the inter-dependence of the individual lamps, and does not involve transformers, while it retains to a great extent the advantages of high pressure. In this system the number of lamps in series is reduced to two, and the groups in parallel are increased. Edison in America, and Hopkinson in England, have improved and perfected the system, allowing each lamp lighted to be quite uninfluenced by the number of lamps alight elsewhere on the circuit. The practice is now to run two dynamos of equal output—and voltage in series—and between the positive (+) of one and the negative (−) of the other, to string the incandescents in series of two. By this means the pressure is double that of the simple parallel system, and the weight of copper required is only one-fourth that of a two-wire network. As, however, the lamps are two in series, turning out one lamp would also extinguish its fellow. To avoid this a neutral wire or equaliser is run from the junction of the two dynamos to the middle connection of the groups of lamps, thus rendering each lamp independent.

The finest example of this method of working is the new station of the Pall Mall and St. James's Company in Mason Yard, Duke Street, St. James, London. The boiler room and dynamo room have been dug out underneath the yard, and a three story fire-proof building of white brick is carried on iron girders and pillars in the centre. The station is laid out for a total capacity of 20,000 16-C.P. lamps. Six Davey-Paxman boilers supply steam to 10 Willans central valve engines, capable of developing 210 H.P. at 350 revolutions, and two smaller ones capable of developing 80 H.P. The engines are mounted on combination bed-plates, upon the other halves of which the field magnets and bearings of the dynamos are supported, the armatures being coupled direct to the engine shafts. The field magnets of the dynamos are vertical, with poles downwards, and supported by brass brackets from the bed-plates. Regulation is effected by inserting resistance into the magnet circuits, which are shunts on the main. The generating sets are arranged in two rows of six each, one on either side of a central gangway towards which all the commutators of the dynamos are directed. The connections from the dynamos pass through suitable regulating and safety appliances before reaching the switchboard from whence the three-wire feeding network is supplied.

The underground system is an air insulated culvert, and the largest main consists of eight strips of copper 2 inches wide by 0·1 inch thick, forming the (+) and (−) leads, while the neutral wire is formed of four strips the same size. The strips are supported by porcelain insulators, and spaced by means of porcelain jockeys, the whole being carried in a cast-iron culvert. This distributing system consists of a complete ring, fed by heavy feeders, and with radial distributors running out beyond the ring. From each feeding point, pilot wires run back to the station, so that the pressure at each point can be ascertained. The pressure on the ring main is kept constant at 107 volts, and houses connected to this main are supplied with 106 volt lamps. Three load diagrams taken towards the end of December, 1889, give evidence of the very high proportion borne by the mean to the maximum demand.

4. PARALLEL SYSTEM WITH BATTERIES.

Example: Kensington Court.

This station, laid down by Messrs. Crompton, was the first station in London under the Electric Lighting Act, and has been extremely successful. At present there are two boilers by Marshall, 15 feet long by 4 feet diameter supplying steam to three coupled Willans engines and Crompton dynamos, one capable of lighting 1,600 16-C.P. lamps, and the two smaller 500 lamps, each of 50 watts. The speed of the dynamos is 370 to 400 revolutions per minute, and the consumption of coal 2·5 lbs. E.H.P. per hour. The load in the station at the end of last year was 1,500 lamps, many of these being 8 C.P., the favourite size on the Kensington Court estate, which is supplied at its limits as far as 950 yards from the generating station. The mains consist of bare copper conductor, laid in a brickwork and cemented culvert having a concrete bottom, and running under the footway. The culvert is 18 inches × 5 inches deep, and is divided into two channels by a mid-feather of brickwork in cement, and the whole is covered with flagstones. In the longitudinal channels thus formed, the copper conductors are strained over porcelain insulators, standing on short iron uprights fixed to the bottom of the channel, and the straining is effected by brass shackles, insulated by glass supports. The insulation thus obtained has been very perfect, and no trouble has resulted so far from moisture. A secondary battery of "Howell's" type is used to supply current when the machines are not running, and to aid the dynamos during the excessive discharge, for a short period each evening.

5. THE ALTERNATING TRANSFORMER SYSTEM.

Examples: West Brompton, Glasgow and Bournemouth.

The model station on the alternating system is certainly that of the House-to-House Company, Limited, who, basing their designs on what had been done at Brighton, Hastings, and Eastbourne, have overcome some of the difficulties of a commercial supply with a periodic current. Their station at West Brompton, situate as some say between the "quick and the dead," lies between the Metropolitan District Railway and the London and Westminster Cemetery, with a frontage to the Richmond Road. The completed station will contain 12 sets of plant each, capable of supplying 4,000 16-C.P. lamps, the engine and boiler room, offices, workshops, testing rooms, engine and drawing offices, taking up a plot of land, 470 feet × 60 feet. Three of the sets of plant are down; and although powers were only obtained in October last, nearly eight miles of underground mains have been laid, and current is supplied to 7,000 incandescent lamps, increasing by 500 per week on its circuits, and it is running permanently and supplying these by meter. Fowler's horizontal coupled compound engine, of 200 H.P. 30-inch stroke, 88 revolutions per minute, drives by seven cotton ropes, 1⅛ inch diameter, from a 14 foot flywheel, a Lowrie-Parker dynamo, with fixed armature and rotating field magnets, capable of maintaining an output of 100 units at a speed of 350 revolutions per minute. The E.M.F. is 2,000 virtual volts, and the periodicity 83. The revolving field magnets are supplied with magnetising current by an exciter driven by four ¾-inch ropes from the shaft of the alternator. This is a series wound Elwell-Parker continuous current machine giving 8 ampères. All wires are brought underground to the testing room, and are brought up at the back of the switchboard, so that it is impossible to touch the high tension connections. The switchboard is constructed in chinaware mounted on ebonite, and connection between the dynamos and mains is made by insertion of the connecting block with four brass pegs. Any circuit can be connected to any dynamo, and it is impossible to short circuit a machine, by reason of the distance of the brass pegs.

The regulation of the dynamo is effected to within 1 per cent. by means of the Lowrie-Hall regulator, which utilises the thermal effects of the current as a means of maintaining a constant E.M.F. across the terminals of the alternator. A thin wire attached at its extremities and weighted at the centre, is connected across one coil of the armature of the alternator, and by its sag allows a rocking arm to make contact with one or other of two tables connected to the two coils of the variable resistance fixed above the wire chamber. The liquid resistance is in shunt with the field magnets of the exciting dynamo, and by weakening or strengthening its field varies the magnetising current to the alternator, and, therefore, the pressure across its terminals. This current at 2,000 virtual volts is distributed underground by means of lead-covered cables drawn into gas pipes, 3, 4, and 5 inches diameter, with joint boxes at suitable intervals.

The mains are of special make, being Fowler-Waring cables, manufactured under Tatham's and Waring's patents. The insulation is the highest yet made for cables, being stated as over 3,000 megohms per mile. The insulation consists of fine braidings saturated with a patent solution, and the cable is then lead covered, and has a coating of hemp over all. The cables are made in five standard sizes to supply 2,000, 1,500, 1,000, 500 and 250 10-C.P. lamps at a distance of 1 mile. The largest cable of this make in use is $\frac{37}{10}$. These cables are not exclusively used by the House-to-House Company, but have been found the most satisfactory up to the present. It is somewhat curious that lead covered conductors should be found so satisfactory for use, with alternating currents, in this country, as there is a great tendency for a spark to break down the dielectric on account of the induced currents in the lead, and in America elaborate apparatus is inserted to do away with this tendency. The cables were also used to carry the 10,000 volts that Mr. Ferranti proposes to use to convey the electrical energy from Deptford to London, and certainly these have been the only cables which have withstood the voltage employed by the London Electric Supply Corporation for any time, and, though they subsequently developed faults, the tension was phenomenal, and no research has up to the present demonstrated what goes on when an abnormal pressure is employed.

Before reaching the switchboard the current has to pass through a high tension fuse consisting of a long length of fine copper wire. The steam supply to the engines is maintained by six Babcock-Wilcox water-tube boilers, capable of evaporating 5,500 lbs. of water per hour, and requiring not more than 1 lb. of best Welsh coal per 10½ lbs. of water evaporated. Working pressure, 150 lbs. per square inch.

The secondary generators or converters, are coupled in parallel on the high tension circuit, and reduce the pressure from 2,000 virtual volts in the primary, to 100 virtual volts on the secondary, with a corresponding increase in the ampèrage. The Lowrie-Hall transformer is one of the "core" class, that is, it has two sets of coils and only one core. It is built up of thin iron plates, each plate being separately insulated from the rest to prevent eddy currents. On each of the individual cores a primary and secondary coil is wound, part of the core projecting beyond the coils at both ends. The coils are then placed side by side, and the plates of the projecting cores are turned over alternately, each pair of plates forms a closed magnetic circuit insulated from the rest, and the two individual cores forms one endless magnetic circuit.

One of the principal points in a system of public supply is that of measurement of the quantity of electricity supplied, and this is an especially difficult problem with alternate or periodic currents. Messrs. Lowrie, Hall and Kollé, have succeeded in utilising the principle of Edison's chemical meter for this purpose, by inserting into the lamp circuit an electrolytic vessel, and cell of constant electromotive force, which will therefore add its difference of potential to one phase, and subtract it from the reversed one, thereby creating a difference in the total quantity that has passed round the circuit positively and negatively. The equivalent therefore is obtained of a continuous current of an amount proportional to the number of lamps that are on the circuit, and the quantity of metal lost by one plate and gained by the other measures the total number of lamp hours or Board of Trade units.

GLASGOW AND BOURNEMOUTH.

Two other systems of high tension alternate current distribution deserve notice as being like the Lowrie-Hall, complete in themselves from generation to dissipation. These are the Ferranti and the Mordey. Glasgow is favoured by having an overhead network of conductors working at 2,400 virtual volts, and as the station worked by Mavor and Coulson is a typical one, it is interesting to compare it with the others.

The station was laid down on ground acquired by Messrs. Muir, Mavor and Coulson, Limited, in Little Hamilton Street. The engines, boilers, and dynamo are on the ground floor, which has an area of about 1,400 square feet, and the plant at present at work is capable of supplying 1,750 16-C.P. incandescent lamps. By the end of this year it is expected another engine and dynamo will be in working order, doubling the power of production. A loco. type steel boiler supplies them at a pressure of 100 lbs. to the square inch, to which feed water is supplied by a Worthington steam pump capable of delivering 2,000 gallons per hour at a slow speed, a self-starting injector capable of feeding two boilers, and a Berryman feed heater.

The motive power consists of a compound non-condensing horizontal tandem engine of the Putnam type, with tappet and cam valves, with cylinders 14 and 22 in. diameter, by 42 in. stroke, and indicating 200 H.P., at 85 revolutions, the flywheel being 14 feet in diameter. This drives by rope gearing a Ferranti alternator 4 feet in diameter, at 450 revolutions per minute, weighing in all 7 tons, and carrying its own exciter on the armature shaft. The exciter, which is shunt wound, supplies 30 ampères at 95 volts to the field circuit of the alternator. Special arrangements have been made for continuous running, in order to maintain a constant supply day and night. A reservoir of oil with level gauge glass is erected above the machine and supplies a constant service to the bearings, the oil passing then to a reservoir from which it is pumped back again.

The switchboard is a double pole one with means of throwing over the distributors on to the Siemens alternator which has an output of 250 ampères, at 50 virtual volts, and is on Kennedy's plan raised to 2,400 virtual volts by means of a large station transformer (which plan has lately been suggested for Deptford as being safer than having 10,000 volts on the dynamos). The small alternator is driven from an inverted cylinder compound engine of 50 H.P. by rope, and is used for the supply during the small hours of the morning. The periodicity of the Ferranti current is 67. The facility with which the field magnets can be separated and the armature exposed for examination is a great practical advantage. On the switchboard are fixed two ampère gauges, and an electrostatic voltmeter of Sir Wm. Thomson's design, the gauges being in the high tension circuits, and the voltmeter being across the terminals of the alternator which is coupled to the supply circuits by means of six fuse boxes also mounted on the switchboard, one for each cable of each circuit and three double pole switches. The fuses are made up of lengths of fine copper wire about one foot long, and are fixed in vulcanite supports at each end of an earthenware box, which is made with internal ridges so as to cause the fuse to blow at a number of places at once. These boxes are ordinarily covered by an earthenware lid. From the double pole switches the six cables pass out of the station on porcelain insulators to the circuits.

Of the six overhead circuits, one supplies the Municipal Buildings, and the others radiate out west, north, and eastwards. In the Municipal Buildings 1,100 lamps are in use, and the current is supplied by meter, that of the Aron pattern, being fixed on the circuit to the six transformers coupled to the various lamp circuits inside the building. Generally, however, the Schallenberger meter is used, and is giving satisfaction, probably superseding the Aron, as its accuracy is greater. It consists of a circular iron disc placed on a vertical arbor attached to connecting mechanism, and also carrying a fan to introduce resistance to movement by air friction. The iron disc rotates very freely. Two diameters of this disc are chosen inclined to each other at 45°. A coil of copper ribbon fixed to the case is coiled round each of these diameters; one of these coils is connected with one of the wires going to the lamps, and the other is closed on itself, and the latter has therefore induced currents circulating in it attaining a maximum a quarter of a period later than the main current, that is when the main current is at zero. Thus we have a continuous rotation of the iron disc when an alternating current is flowing in the main coil. It is a very convenient type of meter for alternate currents, the only objection being that its indications vary with the speed of reversals of the alternating current: our best governors are not perfect, and our most reliable suppliers of electricity would be tempted to alter its indications by increasing the speed of the engines a little.

The Aron meter consists of an ordinary clock with a coil of wire for the bob of the pendulum, and below this is fixed a coil of wire, carrying the current going to the lamps. The effect of the current is to diminish the influence of gravity on the pendulum, and thus cause the clock to lose time. The loss of time as compared with a good uninfluenced clock shows the number of units of electricity which has passed through the instrument. The fact that the clocks require to be wound up militates greatly against the general adoption of this meter, and there are several minor objections to it. The Ferranti converters used in Glasgow are of the shell type, with two cores and one coil, and seem to be equally efficient with the Lowrie-Hall. It will be clear that the exact disposition of the coils and core is immaterial so long as the relative position is maintained: that is, a primary electric inducing circuit linked to a secondary induced circuit by means of a magnetic circuit closed through the primary and the secondary.

The system in use at Bournemouth, and lately laid down at Bournevalley, 2½ miles from the town, is that largely brought out by Mr. Mordey. It is generally accepted that transformers, though economical in that the generating station may be a long distance away from the consumers, do not do away with the necessity for a low tension distributing net-work; and that therefore the system is worked on the principle of one large generating station, and several scattered distributing stations, having large transformers supplying within a radius of something like 200 to 300 yards; and both Mr. Ferranti and Messrs. Lowrie and Hall know this. Mr. Mordey, on the other hand, prefers to allow a transformer to be placed in each consumer's premises, and his system is designed to admit of the greatest flexibility in this respect.

The Bournemouth station is built on a very large plot of land, acquired by the Brush Company, conveniently situated as to supply of fuel and water, and quite free from the objection to the site of former electric works, in so far as there are no risks of causing inconvenience or annoyance from vibration or other trouble to residents. The company have erected a building covering 3,200 square feet, and divided into two by a partition wall forming the boiler and engine rooms. The boilers are made by the Babcock-Wilcox Company, and are of 150 H.P. each. The motive power is furnished by two inverted cylinder compound engines, designed by Raworth, the engineer to the Brush Electrical Engineering Company, of 75 H.P. each. The dynamos are Mordey alternators, each capable of supplying the primary circuit of converters, lighting in all 2,000 lamps. The exciter is a Victoria machine, driven by friction gear, by a smaller engine of the same type as those driving the high tension dynamos. The speciality of the station is the splendid appliances for switching, and the care which has been devoted to minor details, such as fixing a jockey pulley to tighten the endless rope driving.

There seems to be a general desire for uniformity expressed in central station work, as low tension machines are now nearly always driven direct by Willans engines, or high-speed direct-acting engines of a like type, so that a medium speed dynamo may be coupled to the engine shaft.

It is usual in present practice to keep the pressure constant, not at the station, but at some point about the centre of the supply network; and in this connection a volt indicator is quite as useful in regular work as a voltmeter. It is scarcely necessary to explain that by the term indicator is meant an apparatus which will show whether the volts are or are not at their normal value, and, if not, in which direction they are at fault. Such an instrument has only to be calibrated for one particular value, and ought for that reason alone to be much cheaper than a meter. Moreover, as it is only intended to be used at one current strength, there is no objection to the employment of soft iron.

Probably some use might be found for an alternating current volt indicator. The principle of alternating current deflection to which Prof. Fleming in this country, and Prof. Elihu Thomson in America, have devoted attention, would obviously lend itself to this end. The writer is not aware of any application having yet been made of this principle to any instrument for electric lighting work.

The problem of electric lighting from central stations is comparatively easy, if plant can be put down near the centre of the area to be supplied, with the right of way, and powers granted by a provisional order.

When permission can be obtained to lay cables underground, a three-wire system at 220 volts, or continuous current transformer system at 500 volts, has much to recommend it in comparison with the alternating current. Much has been said on the subject of the cost of copper; and the habit of basing estimates of the cost of a network on the price of copper is one to be avoided, having led to erroneous conclusions much too favourable to systems using high E.M.F.

There can be no doubt that there is a possibility of the high tension circuit making contact with the low tension circuit winding in an alternating transformer, and since the former is always joined to the supply leads of the network, there is a constant loss due to want of balance between the primary E.M.F., and the back induction of that coil. With low tension working the highest efficiency occurs during the minimum load, that is for the greater part of the twenty-four hours; while with the high tension, alternating current, the highest efficiency is at full load, and for the greater part of the day the loss is very high—higher than the loss in the low tension system when working at maximum load.

To sum up; on examining all sides of the question, the rival merits of the various systems seem very evenly balanced; each method of distribution is showing itself, *under given circumstances,* to be a sound and practical system to adopt; each method has its own special advantages and disadvantages, and time alone can show which of the many proposed is fittest to survive upon the largest scale; or whether they are all doomed to fall before a system combining the merits and avoiding the demerits of all others.

LONDON COUNTY COUNCIL.

AT the weekly meeting, held at Spring Gardens, the Chairman of the Highways Committee submitted the following report:—

The Electric Lighting Acts impose on the council the duty of testing meters for electric energy supplied for any purposes. In order to perform this duty properly, we are advised that the meters should be tested by means of a current the same in quality, character and periodicity as that for which the meters are to be used. It is therefore desirable that the council should obtain power to require any electric lighting company to supply energy to the testing station now being established, and to any others which may be hereafter established, where such testing station is beyond the limits of the company's area of supply, such energy to be used only for the purposes of testing. They, therefore, recommend that the Parliamentary Committee be instructed to insert in the Council's General Powers Bill of next session a clause giving the council power to require any electric lighting company to supply electrical energy to the council's electric testing stations, even if the station for which the supply is required be beyond the limits of the company's area of supply, and authorising such company, subject to the usual notices, to break up streets for the purpose of laying the mains necessary to afford such supply to the testing station.

The Electric Supply Corporation has served two notices, one (registered No. 128), dated October 30th, 1890 (1 plan), of intention to lay mains in West Strand (part of), Charing Cross (part of), Northumberland Avenue (part of), and the other (registered No. 129), dated November 3rd, 1890 (1 plan), of intention to lay mains in the Strand (part of), and Bedford Street (part of). The proposed interference with so busy a thoroughfare as the Strand is to be deprecated; but the company had statutory power to lay its mains there, and although it has endeavoured by negotiation to adopt a route for these mains in the area of supply of an adjoining company, so as to avoid to some extent the interference with the Strand, it has been unsuccessful. In these circumstances, they were of opinion that the council would not be justified in withholding its consent to the works referred to in the notices, and recommend that the sanction of the council be given to the works referred to in the two notices (registered Nos. 128 and 129), of the Electricity Supply Corporation, dated October 30th and November 3rd, 1890, respectively, upon condition that two days' notice be given to the council's engineer before any of the works are commenced; that the concrete floor of the road-boxes be made 9 inches thick; that the York stone at the top be 4 inches thick; that the longitudinal girders in all the boxes be laid on 3-inch stone templates the full thickness of the brickwork; that the work when commenced shall be continued by day and night shifts, and be carried on so that the traffic shall not be interfered with more than is absolutely necessary; and that the work shall be completed within the shortest time possible.

They had considered a notice (registered No. 130), of the Westminster Electric Supply Corporation, of intention to lay mains in Chesterfield Gardens (1 plan). There appears to be no objection to the proposed works, and recommend that the sanction of the council be given to the works referred to in the notice (registered No. 130), of the Westminster Electric Supply Corporation, dated 6th November, 1890, upon condition that the company do give two days' notice to the council's engineer before commencing the work; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the boxes to be used shall consist of iron frames filled in with materials to suit the paving.

A notice (Registered No. 131), dated 6th November, 1890, has been received from the Metropolitan Electric Supply Company, of intention to lay mains in Exeter Street, Strand (1 plan). The proposed works are of the same character as those of this company previously sanctioned by the council, and recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 131) dated 6th November, 1890, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the council's engineer before commencing the works; that the mains be inclosed in 5-inch iron pipe, and be laid under the footways wherever it is found practicable to do so; that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving; and that the works generally shall be of the description approved by the council on 1st October, 1889.

They had considered a notice, dated November 11th, 1890 (Registered No. 132), from the Kensington and Knightsbridge Electric Lighting Company, of a proposed extension in Church Street (1 plan), and a further notice (Registered No. 133) from the same company, dated November 12th, 1890, of a proposed extension in Hyde Park Gate. The works referred to in these notices are of the ordinary character and it was recommended that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 132 and 133) of the Kensington and Knightsbridge Electric Lighting Company, dated November 11th and November 12th, 1890, respectively.

They had considered an application from the National Telephone Company for permission to lay two lead-covered cables along the entire length of the council's subways between the Mansion House and Westminster Bridge. We are advised that these are subways to which the Metropolitan Subways Act, 1868, applies, and that the council has no power to charge rent for the use of them, but can only make a charge for supervision. There appears to be no objection to these cables being laid in the subway; and therefore recommend that the National Telephone Company be allowed to lay two lead-covered cables in the subways between the Mansion House and Westminster Bridge, upon condition that the cables referred to be laid in such position as the council's engineer may direct, and that the work of laying them be carried out to his satisfaction; that all damage which may be done to the subway in the execution of the work be made good by, and at the expense of the company; and further that the company do undertake to pay such charges, in respect of supervision of all its cables now or hereafter to be placed in the subways, as may be agreed upon between the council and the company at a future time.

THE ELECTRICAL BEHAVIOUR OF CERTAIN AMALGAMS.

A RECENT issue of the *Zeitschrift für Physikalisches Chemie* contains an interesting account of an investigation into the magnitude of the polarisation given by various amalgams in a solution of the corresponding chloride against zinc amalgam. The author is Mons. Le Blanc.

The apparatus employed in this investigation was of an extremely ingenious character; a prominent feature in it was a large tuning fork, which was so adjusted that its vibrations allowed the electromotive force of polarisation to be measured while the primary current was, practically, flowing constantly.

A means of estimating the relative stability of the various amalgams was afforded by the rate of fall of the degree of polarisation after the primary current was interrupted.

Le Blanc found that amongst the amalgams of the metals of the alkalies and alkaline earths, those of lithium and magnesium are the least stable.

A current of electricity from a battery of eight Leclanché cells was passed for about ten minutes in the case of a number of amalgams; with nearly all of is the highest yet made for cables, being stated as over 3,000 megohms per mile. The insulation consists of fine braidings saturated with a patent solution, and the cable is then lead covered, and has a coating of hemp over all. The cables are made in five standard sizes to supply 2,000, 1,500, 1,000, 500 and 250 10-C.P. lamps at a distance of 1 mile. The largest cable of this make in use is $\frac{37}{10}$. These cables are not exclusively used by the House-to-House Company, but have been found the most satisfactory up to the present. It is somewhat curious that lead covered conductors should be found so satisfactory for use, with alternating currents, in this country, as there is a great tendency for a spark to break down the dielectric on account of the induced currents in the lead, and in America elaborate apparatus is inserted to do away with this tendency. The cables were also used to carry the 10,000 volts that Mr. Ferranti proposes to use to convey the electrical energy from Deptford to London, and certainly these have been the only cables which have withstood the voltage employed by the London Electric Supply Corporation for any time, and, though they subsequently developed faults, the tension was phenomenal, and no research has up to the present demonstrated what goes on when an abnormal pressure is employed.

Before reaching the switchboard the current has to pass through a high tension fuse consisting of a long length of fine copper wire. The steam supply to the engines is maintained by six Babcock-Wilcox water-tube boilers, capable of evaporating 5,500 lbs. of water per hour, and requiring not more than 1 lb. of best Welsh coal per 10½ lbs. of water evaporated. Working pressure, 150 lbs. per square inch.

The secondary generators or converters, are coupled in parallel on the high tension circuit, and reduce the pressure from 2,000 virtual volts in the primary, to 100 virtual volts on the secondary, with a corresponding increase in the ampèrage. The Lowrie-Hall transformer is one of the "core" class, that is, it has two sets of coils and only one core. It is built up of thin iron plates, each plate being separately insulated from the rest to prevent eddy currents. On each of the individual cores a primary and secondary coil is wound, part of the core projecting beyond the coils at both ends. The coils are then placed side by side, and the plates of the projecting cores are turned over alternately, each pair of plates forms a closed magnetic circuit insulated from the rest, and the two individual cores forms one endless magnetic circuit.

One of the principal points in a system of public supply is that of measurement of the quantity of electricity supplied, and this is an especially difficult problem with alternate or periodic currents. Messrs. Lowrie, Hall and Kollé, have succeeded in utilising the principle of Edison's chemical meter for this purpose, by inserting into the lamp circuit an electrolytic vessel, and cell of constant electromotive force, which will therefore add its difference of potential to one phase, and subtract it from the reversed one, thereby creating a difference in the total quantity that has passed round the circuit positively and negatively. The equivalent therefore is obtained of a continuous current of an amount proportional to the number of lamps that are on the circuit, and the quantity of metal lost by one plate and gained by the other measures the total number of lamp hours or Board of Trade units.

GLASGOW AND BOURNEMOUTH.

Two other systems of high tension alternate current distribution deserve notice as being like the Lowrie-Hall, complete in themselves from generation to dissipation. These are the Ferranti and the Mordey. Glasgow is favoured by having an overhead network of conductors working at 2,400 virtual volts, and as the station worked by Mavor and Coulson is a typical one, it is interesting to compare it with the others.

The station was laid down on ground acquired by Messrs. Muir, Mavor and Coulson, Limited, in Little Hamilton Street. The engines, boilers, and dynamo are on the ground floor, which has an area of about 1,400 square feet, and the plant at present at work is capable of supplying 1,750 16-C.P. incandescent lamps. By the end of this year it is expected another engine and dynamo will be in working order, doubling the power of production. A loco. type steel boiler supplies them at a pressure of 100 lbs. to the square inch, to which feed water is supplied by a Worthington steam pump capable of delivering 2,000 gallons per hour at a slow speed, a self-starting injector capable of feeding two boilers, and a Berryman feed heater.

The motive power consists of a compound non-condensing horizontal tandem engine of the Putnam type, with tappet and cam valves, with cylinders 14 and 22 in. diameter, by 42 in. stroke, and indicating 200 H.P., at 85 revolutions, the flywheel being 14 feet in diameter. This drives by rope gearing a Ferranti alternator 4 feet in diameter, at 450 revolutions per minute, weighing in all 7 tons, and carrying its own exciter on the armature shaft. The exciter, which is shunt wound, supplies 30 ampères at 95 volts to the field circuit of the alternator. Special arrangements have been made for continuous running, in order to maintain a constant supply day and night. A reservoir of oil with level gauge glass is erected above the machine and supplies a constant service to the bearings, the oil passing then to a reservoir from which it is pumped back again.

The switchboard is a double pole one with means of throwing over the distributors on to the Siemens alternator which has an output of 250 ampères, at 50 virtual volts, and is on Kennedy's plan raised to 2,400 virtual volts by means of a large station transformer (which plan has lately been suggested for Deptford as being safer than having 10,000 volts on the dynamos). The small alternator is driven from an inverted cylinder compound engine of 50 H.P. by rope, and is used for the supply during the small hours of the morning. The periodicity of the Ferranti current is 67. The facility with which the field magnets can be separated and the armature exposed for examination is a great practical advantage. On the switchboard are fixed two ampère gauges, and an electrostatic voltmeter of Sir Wm. Thomson's design, the gauges being in the high tension circuits, and the voltmeter being across the terminals of the alternator which is coupled to the supply circuits by means of six fuse boxes also mounted on the switchboard, one for each cable of each circuit and three double pole switches. The fuses are made up of lengths of fine copper wire about one foot long, and are fixed in vulcanite supports at each end of an earthenware box, which is made with internal ridges so as to cause the fuse to blow at a number of places at once. These boxes are ordinarily covered by an earthenware lid. From the double pole switches the six cables pass out of the station on porcelain insulators to the circuits.

Of the six overhead circuits, one supplies the Municipal Buildings, and the others radiate out west, north, and eastwards. In the Municipal Buildings 1,100 lamps are in use, and the current is supplied by meter, that of the Aron pattern, being fixed on the circuit to the six transformers coupled to the various lamp circuits inside the building. Generally, however, the Schallenberger meter is used, and is giving satisfaction, probably superseding the Aron, as its accuracy is greater. It consists of a circular iron disc placed on a vertical arbor attached to connecting mechanism, and also carrying a fan to introduce resistance to movement by air friction. The iron disc rotates very freely. Two diameters of this disc are chosen inclined to each other at 45°. A coil of copper ribbon fixed to the case is coiled round each of these diameters; one of these coils is connected with one of the wires going to the lamps, and the other is closed on itself, and the latter has therefore induced currents circulating in it attaining a maximum a quarter of a period later than the main current, that is when the main current is at zero. Thus we have a continuous rotation of the iron disc when an alternating current is flowing in the main coil. It is a very convenient type of meter for alternate currents, the only objection being that its indications vary with the speed of reversals of the alternating current: our best governors are not perfect, and our most reliable suppliers of electricity would be tempted to alter its indications by increasing the speed of the engines a little.

The Aron meter consists of an ordinary clock with a coil of wire for the bob of the pendulum, and below this is fixed a coil of wire, carrying the current going to the lamps. The effect of the current is to diminish the influence of gravity on the pendulum, and thus cause the clock to lose time. The loss of time as compared with a good uninfluenced clock shows the number of units of electricity which has passed through the instrument. The fact that the clocks require to be wound up militates greatly against the general adoption of this meter, and there are several minor objections to it. The Ferranti converters used in Glasgow are of the shell type, with two cores and one coil, and seem to be equally efficient with the Lowrie-Hall. It will be clear that the exact disposition of the coils and core is immaterial so long as the relative position is maintained: that is, a primary electric inducing circuit linked to a secondary induced circuit by means of a magnetic circuit closed through the primary and the secondary.

The system in use at Bournemouth, and lately laid down at Bournevalley, 2½ miles from the town, is that largely brought out by Mr. Mordey. It is generally accepted that transformers, though economical in that the generating station may be a long distance away from the consumers, do not do away with the necessity for a low tension distributing net-work; and that therefore the system is worked on the principle of one large generating station, and several scattered distributing stations, having large transformers supplying within a radius of something like 200 to 300 yards; and both Mr. Ferranti and Messrs. Lowrie and Hall know this. Mr. Mordey, on the other hand, prefers to allow a transformer to be placed in each consumer's premises, and his system is designed to admit of the greatest flexibility in this respect.

The Bournemouth station is built on a very large plot of land, acquired by the Brush Company, conveniently situated as to supply of fuel and water, and quite free from the objection to the site of former electric works, in so far as there are no risks of causing inconvenience or annoyance from vibration or other trouble to residents. The company have erected a building covering 3,200 square feet, and divided into two by a partition wall forming the boiler and engine rooms. The boilers are made by the Babcock-Wilcox Company, and are of 150 H.P. each. The motive power is furnished by two inverted cylinder compound engines, designed by Raworth, the engineer to the Brush Electrical Engineering Company, of 75 H.P. each. The dynamos are Mordey alternators, each capable of supplying the primary circuit of converters, lighting in all 2,000 lamps. The exciter is a Victoria machine, driven by friction gear, by a smaller engine of the same type as those driving the high tension dynamos. The speciality of the station is the splendid appliances for switching, and the care which has been devoted to minor details, such as fixing a jockey pulley to tighten the endless rope driving.

There seems to be a general desire for uniformity expressed in central station work, as low tension machines are now nearly always driven direct by Willans engines, or high-speed direct-acting engines of a like type, so that a medium speed dynamo may be coupled to the engine shaft.

It is usual in present practice to keep the pressure constant, not at the station, but at some point about the centre of the supply network; and in this connection a volt indicator is quite as useful in regular work as a voltmeter. It is scarcely necessary to explain that by the term indicator is meant an apparatus which will show whether the volts are or are not at their normal value, and, if not, in which direction they are at fault. Such an instrument has only to be calibrated for one particular value, and ought for that reason alone to be much cheaper than a meter. Moreover, as it is only intended to be used at one current strength, there is no objection to the employment of soft iron.

Probably some use might be found for an alternating current volt indicator. The principle of alternating current deflection to which Prof. Fleming in this country, and Prof. Elihu Thomson in America, have devoted attention, would obviously lend itself to this end. The writer is not aware of any application having yet been made of this principle to any instrument for electric lighting work.

The problem of electric lighting from central stations is comparatively easy, if plant can be put down near the centre of the area to be supplied, with the right of way, and powers granted by a provisional order.

When permission can be obtained to lay cables underground, a three-wire system at 220 volts, or continuous current transformer system at 500 volts, has much to recommend it in comparison with the alternating current. Much has been said on the subject of the cost of copper; and the habit of basing estimates of the cost of a network on the price of copper is one to be avoided, having led to erroneous conclusions much too favourable to systems using high E.M.F.

There can be no doubt that there is a possibility of the high tension circuit making contact with the low tension circuit winding in an alternating transformer, and since the former is always joined to the supply leads of the network, there is a constant loss due to want of balance between the primary E.M.F., and the back induction of that coil. With low tension working the highest efficiency occurs during the minimum load, that is for the greater part of the twenty-four hours; while with the high tension, alternating current, the highest efficiency is at full load, and for the greater part of the day the loss is very high—higher than the loss in the low tension system when working at maximum load.

To sum up; on examining all sides of the question, the rival merits of the various systems seem very evenly balanced; each method of distribution is showing itself, *under given circumstances*, to be a sound and practical system to adopt; each method has its own special advantages and disadvantages, and time alone can show which of the many proposed is fittest to survive upon the largest scale; or whether they are all doomed to fall before a system combining the merits and avoiding the demerits of all others.

LONDON COUNTY COUNCIL.

AT the weekly meeting, held at Spring Gardens, the Chairman of the Highways Committee submitted the following report:—

The Electric Lighting Acts impose on the council the duty of testing meters for electric energy supplied for any purposes. In order to perform this duty properly, we are advised that the meters should be tested by means of a current the same in quality, character and periodicity as that for which the meters are to be used. It is therefore desirable that the council should obtain power to require any electric lighting company to supply energy to the testing station now being established, and to any others which may be hereafter established, where such testing station is beyond the limits of the company's area of supply, such energy to be used only for the purposes of testing. They, therefore, recommend that the Parliamentary Committee be instructed to insert in the Council's General Powers Bill of next session a clause giving the council power to require any electric lighting company to supply electrical energy to the council's electric testing stations, even if the station for which the supply is required be beyond the limits of the company's area of supply, and authorising such company, subject to the usual notices, to break up streets for the purpose of laying the mains necessary to afford such supply to the testing station.

The Electric Supply Corporation has served two notices, one (registered No. 128), dated October 30th, 1890 (1 plan), of intention to lay mains in West Strand (part of), Charing Cross (part of), Northumberland Avenue (part of), and the other (registered No. 129), dated November 3rd, 1890 (1 plan), of intention to lay mains in the Strand (part of), and Bedford Street (part of). The proposed interference with so busy a thoroughfare as the Strand is to be deprecated; but the company had statutory power to lay its mains there, and although it has endeavoured by negotiation to adopt a route for these mains in the area of supply of an adjoining company, so as to avoid to some extent the interference with the Strand, it has been unsuccessful. In these circumstances, they were of opinion that the council would not be justified in withholding its consent to the works referred to in the notices, and recommend that the sanction of the council be given to the works referred to in the two notices (registered Nos. 128 and 129), of the Electricity Supply Corporation, dated October 30th and November 3rd, 1890, respectively, upon condition that two days' notice be given to the council's engineer before any of the works are commenced; that the concrete floor of the road-boxes be made 9 inches thick; that the York stone at the top be 4 inches thick; that the longitudinal girders in all the boxes be laid on 3-inch stone templates the full thickness of the brickwork; that the work when commenced shall be continued by day and night shifts, and be carried on so that the traffic shall not be interfered with more than is absolutely necessary; and that the work shall be completed within the shortest time possible.

They had considered a notice (registered No. 130), of the Westminster Electric Supply Corporation, of intention to lay mains in Chesterfield Gardens (1 plan). There appears to be no objection to the proposed works, and recommend that the sanction of the council be given to the works referred to in the notice (registered No. 130), of the Westminster Electric Supply Corporation, dated 6th November, 1890, upon condition that the company do give two days' notice to the council's engineer before commencing the work; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the boxes to be used shall consist of iron frames filled in with materials to suit the paving.

A notice (Registered No. 131), dated 6th November, 1890, has been received from the Metropolitan Electric Supply Company, of intention to lay mains in Exeter Street, Strand (1 plan). The proposed works are of the same character as those of this company previously sanctioned by the council, and recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 131) dated 6th November, 1890, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the council's engineer before commencing the works; that the mains be inclosed in 5-inch iron pipe, and be laid under the footways wherever it is found practicable to do so; that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving; and that the works generally shall be of the description approved by the council on 1st October, 1889.

They had considered a notice, dated November 11th, 1890 (Registered No. 132), from the Kensington and Knightsbridge Electric Lighting Company, of a proposed extension in Church Street (1 plan), and a further notice (Registered No. 133) from the same company, dated November 12th, 1890, of a proposed extension in Hyde Park Gate. The works referred to in these notices are of the ordinary character and it was recommended that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 132 and 133) of the Kensington and Knightsbridge Electric Lighting Company, dated November 11th and November 12th, 1890, respectively.

They had considered an application from the National Telephone Company for permission to lay two lead-covered cables along the entire length of the council's subways between the Mansion House and Westminster Bridge. We are advised that these are subways to which the Metropolitan Subways Act, 1868, applies, and that the council has no power to charge rent for the use of them, but can only make a charge for supervision. There appears to be no objection to these cables being laid in the subway; and therefore recommend that the National Telephone Company be allowed to lay two lead-covered cables in the subways between the Mansion House and Westminster Bridge, upon condition that the cables referred to be laid in such position as the council's engineer may direct, and that the work of laying them be carried out to his satisfaction; that all damage which may be done to the subway in the execution of the work be made good by, and at the expense of the company; and further that the company do undertake to pay such charges, in respect of supervision of all its cables now or hereafter to be placed in the subways, as may be agreed upon between the council and the company at a future time.

THE ELECTRICAL BEHAVIOUR OF CERTAIN AMALGAMS.

A RECENT issue of the *Zeitschrift für Physikalisches Chemie* contains an interesting account of an investigation into the magnitude of the polarisation given by various amalgams in a solution of the corresponding chloride against zinc amalgam. The author is Mons. Le Blanc.

The apparatus employed in this investigation was of an extremely ingenious character; a prominent feature in it was a large tuning fork, which was so adjusted that its vibrations allowed the electromotive force of polarisation to be measured while the primary current was, practically, flowing constantly.

A means of estimating the relative stability of the various amalgams was afforded by the rate of fall of the degree of polarisation after the primary current was interrupted.

Le Blanc found that amongst the amalgams of the metals of the alkalies and alkaline earths, those of lithium and magnesium are the least stable.

A current of electricity from a battery of eight Leclanché cells was passed for about ten minutes in the case of a number of amalgams; with nearly all of them there was but a very slight disengagement of gas. With the amalgams of magnesium and lithium, however, there was a comparatively active evolution of gas.

It was found by Le Blanc that when a mixture of solutions of zinc chloride and hydrochloric acid were dealt with, a quantity of zinc amalgam was deposited at the negative pole; this, he considers, indicates that *atomic* hydrogen displaces the metal zinc in its salts.

A new light is thrown upon the vexed question of ammonium and alkyl ammonium amalgams. Most of the text-books question the existence of ammonium amalgam. Let us take an instance and quote from a very well-known book. "When a solution of ammonium chloride is poured over sodium amalgam a soft slimy mass is formed, which swells up to many times the original bulk of the sodium amalgam. This curious substance has been termed an ammonium-amalgam, on the assumption that it was a combination of the radicle NH_4 with mercury. In reality, however, it is nothing but a mercurial froth inflated with a mixture of ammonia and hydrogen."

Ammonium-amalgam was discovered almost simultaneously by Berzelius and Pontin (vide Gilbert's *Annalen der Physik und Chemie*, vol. vi., p. 260) and by Seebeck (vide *Gehlen, Allg. Journ. Chemie*, vol. v., p. 482). It can be readily obtained when a current from a galvanic battery is passed through aqueous ammonia or through an aqueous solution of an ammonium salt containing metallic mercury placed in connection with the negative pole. The same substance is formed when a globule of mercury is placed on a piece of moistened sal-ammoniac and connected with the negative side of a voltaic battery of very moderate power, the circuit being completed through a platinum plate upon which the sal-ammoniac rests; decomposition of the latter rapidly ensues, and ammonium amalgam is formed. Sir Humphrey Davy described it as a butter-like mass of a grey metallic appearance, and much lighter than water. At ordinary temperatures it quickly decomposes into mercury, ammonia and free hydrogen, but at the freezing point it crystallises in cubes, and according to Grove does not decompose spontaneously.

Endless discussions have taken place over this amalgam, and the balance of opinion has been fairly evenly divided. Le Blanc's work sets this question at rest, for the phenomena which he observed with solutions of the ammonium chlorides are quite comparable with those obtained when the metallic chlorides are employed. This goes to prove that the ammonium and alkyl-ammonium amalgams have an actual existence.

These amalgams, however, as might be supposed, are much less stable than the metallic amalgams usually are—a point which is well illustrated by the fact that the electromotive force of polarisation falls off in a relatively rapid degree as the primary current ceases to flow.

Besides the interesting amalgam of the hypothetical radicle ammonium. Le Blanc investigated the following compound radicle amalgams:—

Methyl-ammonium amalgam.
Ethyl-ammonium amalgam.
Di-methyl-ammonium amalgam.
Di-ethyl-ammonium amalgam.
Tri-methyl-ammonium amalgam.
Tri-ethyl-ammonium amalgam.
Tetra-methyl-ammonium amalgam.

Of these the most unstable is tri-ethyl-ammonium amalgam, and it is rather doubtful whether it really exists. The tri-methyl and the di-ethyl-ammonium amalgams are also extremely unstable.

The formation of a mercury "froth" on the surface of the liquid during the process of electrolysis has hitherto been held to be a capital indication of the formation of an amalgam, but this view must be modified. Le Blanc's investigation shows that in the case of the ethyl-ammonium amalgam no froth rises to the surface, and yet the electrical behaviour shows beyond a shadow of doubt that a definite and comparatively stable amalgam has been formed.

Those of our readers who know German, and may wish to examine into the details of this interesting piece of research may consult the "Zeitschrift für Physikalisches Chemie," vol. v., commencing at page 467.

FIRE AT GROSVENOR GALLERY CENTRAL STATION.

MR. FERRANTI has kindly supplied us with the following facts relating to the fire at the Grosvenor Gallery:—

"Up till recently the Grosvenor Station was supplying the whole of the lights of the London Electric Supply Corporation. Due to the obtaining of an injunction by the neighbours, the corporation has been obliged to abandon this station for generating purposes, and use it only for a distributing station. It was necessary, so far as was possible, to stop down the Grosvenor generating station, turn out a certain portion of the machinery which had been running there, and instal the necessary converting machinery for the purpose of transforming from the high tension to the intermediate tension for supplying to the customers. All this had to be done with the minimum of delay. It was, therefore, a case of stopping down on Saturday nights, and working as hard as possible to finish the installation of the transformer machinery by as early an hour on Sunday afternoons as possible. This process was partly done. The whole of the work which was put in was of an entirely temporary nature, India-rubber-covered wires being used for carrying the current, light woodwork being used to support these wires, and the switches instead of being upon permanent supports were held by woodwork."

"The accident occurred at 6·30 on Saturday morning, owing to the action of a linesman in plugging on a fresh set of converters. The man was not sufficiently cool for this particular purpose. Hesitating in putting on the switch, it arced slightly: instead of pushing it in, he drew it back and broke the contact. The heated surfaces, together with the 5,000 volts pressure which was being used, caused the arc to maintain. It ran up the woodwork and set light to the ceiling, which was composed of cross-boards with tar between for the purpose of keeping out moisture from the tank which formed the roof. The whole place was burned down in the brief space of twenty minutes. An hour after the accident occurred the whole place was quiet and fairly cool. The linesman had ample opportunity of entirely stopping any damage from his first carelessness, because the switch which he put on was only a plug, and meant for connecting a circuit, there being a large switch within a yard's distance for breaking the supply passing through the plug switches. If he had been too frightened to turn off the switch, he had again another safeguard in the safety switch at the end of the room, which would cut off the whole supply from Deptford. He also had the option of signalling to Deptford to stop the supply, but this was stopped before the man could have finished signalling, as they saw by the action of the ammeters and voltmeters at Deptford that something was wrong in London."

We believe that the cost of the destroyed apparatus amounts to between £15,000 and £20,000, all of which was uninsured.

Electric Lighting in Panama.—An electric light company, acting under contract with the Municipal Government, has introduced the electric light for public and private purposes in the town of Panama. The lighting of the streets is effected by 43 arc lamps, and 300 glow lamps are installed on private premises.

NOTES.

The Electric Light at Bath.—At a meeting of the Town Council last week, Mr. Sturges, on moving the adoption of the report of the Special Electric Lighting Committee, complimented Mr. Massingham upon the success of his installation. He also congratulated Bath upon having taken the position it had done in the matter of the electric light, and upon this important and beautiful improvement in the lighting of the town and houses having been so readily adopted. He advocated an independent inspection by a leading electrician. Mr. Massingham had stated that he would be better satisfied if they employed an expert of the highest standing they could find—that was Mr. Preece; and he would move, as an addition to the report, that they employ a scientist of sufficient eminence to inspect the whole of the works and report to the council. Mr. Sturges added that the Board of Trade would insist on inserting a clause in Mr. Massingham's license that he should not be compelled to sell at the end of seven years, if he wanted an extension. Mr. Massingham, however, was perfectly willing not to have such a clause, but the Board of Trade insisted that he should. In the course of the discussion which ensued, General Burn expressed an opinion that the new illuminant was an immense improvement on the old gas light, and as a practical proof of its superiority he mentioned that a threepenny piece placed on the pavement between two of the electric standards could be seen easily, whereas it was impossible to detect a similar coin placed on the pavement between two gas lamps. At the close of the discussion the report was unanimously adopted.

Electric Lighting at Stroud.—A public meeting a few nights ago at Stroud approved of a scheme for lighting the town by electricity.

Ship Lighting.—Last week Messrs. David W. Henderson, Glasgow, launched to the order of Messrs. J. and A. Allan, the steel screw steamer *Mongolian*. She is fitted throughout with the electric light. A sister ship to the *Mongolian* will be launched in the spring of next year.

French Submarine Cables.—In reviewing the work now being accomplished in the West Indies by the Société Française des Télégraphes Sous-marins, and while congratulating the Ministry for the Colonies on the zeal it has displayed in this direction, the Paris technical press points out that there are other and more urgent telegraphic communications to be established. The places with the most pressing need for cable connection are Réunion, Maurice, and Madagascar, which represent most important interests, long suffering from inattention; the Comoro Islands and New Caledonia, also, claim the consideration of Government.

Important to Electric Light Companies.—At a recent meeting of the Paris Municipal Council the following measures were agreed to:—Parliament is invited to pass a special law to assimilate the electric lighting industry with those enterprises which, being considered dangerous, are under the constant supervision of the Prefecture of Police. The administration is invited to inscribe in the conditions of contract for electrical companies, whenever a new concession may be asked for, the express obligation to employ smoke-consuming apparatus, or to make use of combustibles which do not give off smoke.

Canal Traffic.—A German contemporary states that a Magdeburg firm will shortly make experiments on the Finow Canal with boats and timber rafts worked by electricity.

A Bordeaux Exhibition.—An electrical section is being formed in this international exhibition, which is to be opened in Bordeaux in May next.

A Long Price.—The English and German electric light companies in Madrid maintain the high price of 14d. to 15d. per unit. The expression "go to Bath," to inspect Mr. Massingham's lighting and charges, must now be changed to "go to Madrid."

Italian Electro-Technical Schools.—There are three electro-technical schools in Italy. One is situated in Milan, the second in Turin, and the third in Naples.

Another Franco-Danish Cable.—The President of the Republic has just signed a decree regulating the laying and working of a second telegraphic cable between Calais and Denmark.

The Theatrephone.—The theatrephone is about to be installed in several of the Paris clubs, notably in that of the Union Artistique, where it will shortly be at work.

Personal.—Sir Frederick Abel, F.R.S., has accepted the seat on the board of J. C. and J. Field, rendered vacant by the death of Mr. G. Maule.

The Royal Society.—The following papers were down for reading yesterday:—Prof. J. V. Jones, "On the Determination of the Specific Resistance of Mercury in Absolute Measure." Dr. Hopkinson, F.R.S., "Magnetism and Recalescence."

The Old Students' Association.—A Cinderella dance will be held at the Westminster Town Hall on Friday, December 12th, 1890. Tickets, 3s. 6d. each, may be obtained from the members of the committee, or from Mr. Reginald J. Jones, hon. sec.

A Valuable Publication.—The sixth edition of "Electric Lighting and the Management of Accumulators," by Sir David Salomons, Bart., will shortly be published.

Tenders Wanted.—Bombay.—Sealed tenders will be received by the Municipal Commissioner for the city of Bombay up to 1 p.m. on February 16th for experimental lighting by electricity of certain streets of the city of Bombay for two years. Forms of tender and schedule of conditions, and a sketch of the portion of the city, showing the streets to be lighted, may, on payment of £1 sterling, be obtained from Messrs. E. W. and R. Oliver, 1, Corbet Court, Gracechurch Street, London, E.C., who will, on application, give any further information that may be required. Tenders must be accompanied by a deposit of one thousand rupees in cash (not to bear interest), or in public securities for that amount to be paid to the chief accountant of the Municipality of Bombay, which will be forfeited to the corporation in case of refusal to sign the contract embodying the conditions mentioned in the schedule above referred to. A further payment, to make the total deposit equivalent to 5 per cent. on the contract amount, will have to be made by the contractor whose tender may be accepted, before signing the contract. Mr. Rienzi Walton, executive engineer, Municipality, Bombay.

Edmonton. — For lighting public hall, stores, &c., Letters to Mr. Walker, people's provider, Upper Edmonton.

Mr. Tesla on Sound Views.—In a letter to *Industries* on alternating motors, Mr. Nikola Tesla concludes an able letter as follows:—"You state that I have misinterpreted my results, and it looks as though you believe my views to be unsound. Your arguments are those of an eminent scholar. I was myself a fair scholar. For years I pondered, so to speak, day and night over books, and filled my head with sound views—very sound ones, indeed—those of others. But I could no get to practical results. I then began to work and think independently. Gradually my views became unsound, but they conducted me to some sound results."

Failure of Accumulator Traction in Australia.—The Victorian *Electrical and Telegraphic Journal* for last month contains the following suggestive paragraphs :—

"The Sandhurst and Eaglehawk Electric Tramway Company ceased running on Wednesday, 24th September, the accumulator system of traction having proved a failure. This will be noted with regret by the public as well as shareholders. The latter are worthy of much praise for the persistent resolve to succeed if success were attainable."

"It is curious to note that the only accumulator-driven system which was alleged to be a commercial success, that on the Barking Road, London, is now proved to be a commercial failure, to judge by the reports in the electrical press of late date."

"This company were using the same cars and motors as the Sandhurst Company. This latter company may, if the requisite power be obtained, adopt the overhead wire system, which has proved successful in America.

Western Counties and South Wales Telephone Company.—We must take this opportunity of expressing satisfaction at the continuous progress of this company, which forms at once an example for other enterprises with far greater pretensions. A few months ago the company was approached by the Port of Plymouth Chamber of Commerce with a view to establishing a signal station on Rame Head for reporting by telephone to Plymouth all vessels passing up or down Channel or entering the port, as well as casualties and other shipping news of interest. No time has been lost, and provided that arrangements can be made with the Admiralty, the station will be in working order in a few weeks. The Devon and Cornwall Homœopathic Dispensary and Cottage Hospital is in connection with the exchange system free of charge, and among the more recent developments of the system is the conversion of the single trunk line to Plympton, Ivybridge, and Avonwick into a metallic circuit or double wire. A tradesman at Plympton can now converse with any subscriber in the Three Towns for an annual rental of £10, and a private resident will have the same privilege for £5 per annum, provided he lives within a quarter of a mile from the Plympton office, £1 5s. per annum being charged for every additional quarter of a mile. Similar services to this will be established at other places early in the new year.

Electric Light Mains.—Messrs. Henley's Telegraph Works Company, Limited, has favoured us with samples of electric light mains covered with vulcanized India-rubber which the company has been, and is, supplying to the Kensington and Knightsbridge Electric Supply Company, Westminster Electric Supply Company, Notting Hill Company, Crompton & Co., &c. It is believed that the largest of these samples, viz., 61/10s is the heaviest vulcanized India-rubber cable that has ever been made. The weight of the conductor alone is 7¼ tons, and its sectional area is ¾ square inch. Judging from the samples before us, the company should feel itself well satisfied with its manufactures both electrically and mechanically.

"Darkest England and the Way Out."—The staff and men of the dynamo department in the works of W. T. Goolden & Co. having resolved to raise a subscription to aid General Booth in his great work of endeavouring to raise the lapsed masses of his fellow men, it was at once started vigorously, and chiefly through the sympathetic influence of C. W. Atkinson, Esq., the sum of six guineas was in a few hours collected and forwarded to General Booth last Saturday. The instrument department staff may possibly send in a contribution, but no definite steps have up till now been taken in the matter.

A New Cable.—The Great Northern Telegraph Company is about to lay a new direct cable between Fano, off the West Coast of Jutland, and Calais.

Electrical Engineers Students' Meetings.—There will be no students' meeting held on Friday next, as advertised. On the 5th proximo, Mr. Garret will read a paper on "Search Light Work."

Catalogue.—We have received a catalogue of technical books "On the Mechanical Arts" from the Britannia Company, Colchester.

Telephones in Russia.—A French company has recently obtained a concession from the Russian Government for the construction of a telephone system between St. Petersburg, Moscow, Warsaw, and Berlin. The charge for the use of the telephone will be 8 francs for the first minute, and 4 francs each additional minute.

Prices of Incandescent Lamps.—Mr. C. J. Robertson, writing from Aldersgate Street, says :—"I notice in your last issue a note on the present low price of incandescent lamps in the States (*i.e.*, 44 cents. each). I thought it might interest you to hear that I am myself supplying lamps (made within 300 miles of London), of a quality and durability second to none—including the 'Edison-Swan'—at the still lower price of 1s. 7d. (*i.e.*, 38 cents, American) each, fitted and delivered free, and there is every prospect of lowering this price in the near future."

Tapping Holes in Porcelain with Fine Threads.—Messrs. Buller's, Limited, send us the following note :—"From the paragraph in the REVIEW of last week, it might be inferred that there had been some difficulty in obtaining porcelain fittings for electric lighting with holes tapped to receive metal screws. For many years past we have tapped holes in porcelain to fit metal screws with complete success, and therefore when the demand for this feature in electric lighting ware came, we had no difficuly in meeting it. We beg to send you a ceiling rose with screwed holes, made by us some months ago. To our customers we have supplied many thousand pieces of ware with tapped holes, and the results have already been very satisfactory. Our screws are made to a series of standard gauges, which in diameter and pitch cover the whole requirements of the trade." Certainly the sample sent to us is an excellent specimen of manufacture, the screws running perfectly true and smooth

The Government and the Telephone.—Under this heading an article appeared recently in the *Scotsman* in which attention is drawn to the Van Rysselberghe system of telephoning on ordinary working telegraph wires. It is stated that, "Hitherto not a step has been taken towards the adoption of the system in this country;" and again, "If it should be found as available here as it is in Belgium and in France—and there is no reason why it should not—the Government will have the most comprehensive means of telephoning to be found in the country," and much more to the same effect. The writer of the article was evidently ignorant of what he was writing about, otherwise he would not have argued in the strain he did. The Van Rysselberghe system has, we believe, been tried in this country and found to be a failure, first, because it necessitates the addition of electro-magnets in the line wire, which cuts down the working speed of the fast speed apparatus so widely used, and secondly, because the addition of these electro-magnets renders it necessary to greatly increase the ordinary working battery power of the telegraph circuits. In the case of Belgium, we believe, it has been found necessary to double the power on the circuits all round, and the consequent expense and trouble more than counterbalances the gain of telephone working being possible. It is whispered, also, that the Telegraph Service is by no means pleased with the system, but that it has, unfortunately, bound its hands in such a way, that they cannot be freed.

Greenock Philosophical Society.—Mr. A. Denny, Dumbarton, last Friday night, lectured to this society on "Electricity, and its Practical Applications." The hall was electrically lighted for the occasion, and the lecture was interspersed with numerous experiments and illustrations.

The Institution of Electrical Engineers.—The next meeting will be held on Thursday, 27th November, at 8.0 p.m., when the adjourned discussion on the following papers will be continued:—"The Efficiency of Secondary Cells;" "On the Chemistry of Secondary Cells;" by Prof. W. E. Ayrton, F.R.S., Vice-President; C. G. Lamb, B.Sc., and E. W. Smith, associates.

The National Telephone Company's Exchanges.—The National Telephone Company, Limited, announce that the trunk line between the London, Manchester, Liverpool, and Birmingham Exchanges is now open to the public.

The Electro-Deposition of Copper.—We have received since our Correspondence pages went to press a long letter from Mr. W. Stepney Rawson, who simply reiterates the contents of his previous communication without in any way making his case better. Out of politeness to him, and also to show how much more diplomatic it is to beat about the bush than to come to an issue, we shall publish his letter in our next, together with a report on the Elmore process formulated by M. Secretan and others, which is so deliciously vague that our readers may anticipate a real literary treat. We have failed to elicit the information from Mr. Rawson which we requested, for he steers clear of the rock on which he would have split by declaring that the Elmore Company has objected to the figures of cost being given by him. While on this topic, it may not be amiss to call attention to a letter from Mr. William Elmore, which appeared yesterday in the *Financial Times*. This gentleman's object is to allay the alarm which has been caused by the depreciation of Elmore shares, but we doubt very much whether his explanations will have the desired effect. So far as the company's works are concerned, says he, they continue daily to improve; but what the general public desire to see is not so much a daily improvement in works which are supposed to turn out some scores of tons of copper per week, and which certainly ought to have been in readiness months ago, as a real sale for the manufactured articles. We have every reason to believe that up to the present date five tons would cover all that the Elmore Company has turned out, and Mr. Elmore's statement that he has increased his holding of shares during the past week may show either confidence in his system, or, on the other hand, that he is trying to keep the market firm for yet a little while to float still another company. How near to the truth this last supposition may be we leave for commercially inclined readers to determine, merely calling attention to the following extract from an article "Still more Elmore," in the *Financial Times* of Wednesday, and which is well worthy of perusal in full:—"There are now four Elmore Companies, all producing no end of circulars and no end of securities, but no patent copper. Now there is to be a fifth. It is not to produce copper. Oh, dear no! It is to be called a Trust, and its function is to foist a lot of Elmore vendor shares, which of course are unsaleable just now, on the public. This is the prettiest thing in 'trust' schemes that has been evolved, and it is also the culminating point of the ingenuity of the Elmore promoters. The chief advantage of the scheme, as set out in the latest Elmore circular, is that the public will be enabled, by means of this trust, to invest in the valuable Elmore securities." To judge from the fall in the price of shares of the original company the public requires a good deal of persuasion to indulge in the luxury of Elmore securities at fancy values, and it is not likely to jump at the chance of obtaining diluted interest in the worst of them.

The Northfleet Electric Tram Line.—The series electrical traction system at Northfleet has been discontinued. The line, as is well known, was for demonstrative purposes only, and its object having now been attained, there is no further reason for incurring the large expense necessitated by the smallness of the local traffic, and the heavy rental and charges imposed by the Gravesend, Rosherville and Northfleet Tramway Company, through whom the Parliamentary powers were obtained. Careful accounts have been kept of the cost of running for the last six months, and from these, when audited, the actual cost of motive power on the series system will be made public.

To Elmore Shareholders.—On the 12th September, 1876, Mr. Henry Wilde, of Manchester, patented an invention (Specification No. 3,569) for "Improvements in the manufacture of metal rollers for printing calico *and for other purposes*." It may be interesting to the holders of Elmore shares to compare this with what they know of the process on which they have built their hopes, and for this purpose we give the following extract from the text:—"Now my present improvements consists, firstly, in a method of securing a sufficient amount of adhesion between the iron and deposited copper surfaces, to enable the roller to withstand the various engraving and other operations without the separation of the metals. For this purpose the iron roller, before receiving a coating of copper from a hot cyanide solution of copper, is heated to a temperature ranging from 150° to 212° Fahrenheit, by plunging it into boiling water, or by other means. The said roller, after receiving a film deposit of copper from the cyanide solution, is then transferred to the bath containing a sulphate solution of copper, where it receives one or more thin coatings of copper. *These coatings are subjected to considerable pressure by the action of a burnishing roller of hardened steel*, for the double purpose of forcing the deposited copper into closer contact with the iron, and detecting any want of adhesion between the two metals. The burnished coppered roller is then replaced in the bath of sulphate of copper solution, and *subjected to the action of the electric current until the desired thickness of copper deposit is obtained*. Before each of the depositing operations the surface of the roller is thoroughly cleansed by scouring and washing in clean water, as is well understood. Having thus stated the nature of my invention, and described the manner of performing the same, I declare that I claim,—First. Heating iron rollers to prepare them for receiving a film deposit of copper from a cyanide solution. Secondly. *Depositing one or more thin coatings of copper from a sulphate solution, and burnishing the same before the final coating is deposited for the purpose described.*

Electrical Engineers Conversazione.—The annual *conversazione* of this Institution was held on Wednesday, the 19th, in the Galleries of the Society of Painters in Water Colours, and was the largest and most brilliant of a long series. The company, numbering about 1,000, was received by the president, Dr. John Hopkinson, and Mrs. Hopkinson. A large number of distinguished visitors and scientific men were present, including the Solicitor-General, Sir Frederick Bramwell, Dr. Gladstone, Prof. Frankland, Sir Albert Cappel, Sir James Douglass, Sir Douglas Galton, Sir David Salomons, Sir Henry Mance, Major-General C. E. Webber, &c. The Coldstream Guards' band played in the Galleries and the Bijou Orchestra in the Prince's Hall. Ladies formed a very considerable portion of the concourse, and added brilliancy to the scene.

The Mistake Obvious.—In reference to our note last week, "A 200,000-watt Arc Lamp," Mons. W. de Fonvielle writes to explain that by a misprint in a French contemporary, 50 volts became 500. The mistake, we need scarcely say, was doubtless apparent to our readers, and, as our correspondent remarks, is scarcely worth referring to again.

Electric Light at Madame Tussaud's.—A complete installation of the electric light at Madame Tussaud's has been erected by Messrs. Drake and Gorham, superintended by Mr. Gisbert Kapp. Two dynamos are used, driven by two of Crossley's gas engines of 25 horsepower, in addition to which batteries are employed. We may mention that the whole of the work (excavating, building engine-house, &c.) had to be undertaken by the electricians, and the result is a very neat and compact station.

Edison Underground Work.—The Edison Company of Boston has two stations supplying 32,000 incandescence lamps and 50 Ward arc lights, with a motive power of 1,400 H.P. The underground system has an extension of two miles, with 40 miles of feeders and mains. The longest feeder is about 6,000 feet. Railway bridges are crossed by means of a Clark specially prepared cable, pulled through a 3-inch gas pipe. The crossing to South Boston will be made by an armoured Clark submarine cable.

Electricity in a Silver Mine.—Since the introduction of electric machinery of the Westinghouse manufacture into several Pennsylvania coal mines, the demand for that company's apparatus is rapidly increasing. The Westinghouse Company is now engaged in manufacturing power apparatus for the operation of a silver mine owned by the Gold King Mining Company of Telluride, Colo., L. A. Munn of that city being the president of the company. The mine in question is situated on the top of a mountain about 2,000 feet high, and as the cost of coal is a great factor in the operation of a mine under such circumstances, the advantages of electric power over steam can be easily appreciated.

The Priority of the Electrical Gyroscope. — M. Dumoulin-Froment claims against M. Trouvé the invention of the electrical gyroscope. It appears that the gyroscope was invented by Foucault in 1850, and in 1867 M. Froment showed in the Champs de Mars Palace an instrument worked by electrical mechanism, whilst M. Trouvé only presented his to the Académie des Sciences in September last. Our readers may recollect that we gave an illustrated description of an electrical gyroscope devised by Mr. G. M. Hopkins in our issue for August 15th, 1878.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Brush Electrical Engineering Company, Limited.—The annual return of this company, made up to the 22nd September, was filed on the 12th inst. The nominal capital is £750,000 divided into 150,000 ordinary shares of £3 each and 150,000 preference shares of £2 each. The shares taken are 76,978 ordinary and 68,996 preference shares, and upon 68,914 of the former and 68,914 of the latter the sum of £344,570 is considered as paid up. The full amount has been called upon the remaining shares, the total of the calls paid amounting to £24,353 10s. and unpaid £2 10s.

NEW COMPANIES REGISTERED.

Electricity and Electrical Engineering Newspaper Company, Limited.—Capital £500, in £10 shares. Objects: To establish and work a newspaper devoted to the interests of electrical science in all its branches. Signatories (with 1 share each): Wm. Swan Sonnenschein, 62, Russell Square; H. Wigham, Uplands, East Sheen; R. Oswald Smith, 73, Eaton Square; F. C. Tilney, 126, Corbyn Street, Stroud Green; Julius Maier, Ph.D., 23, Melrose Gardens, S.W.; F. D. Summers, 13, Oberstein Road, Wandsworth; George Newnes, M.P., Wildcroft, Putney Heath. Registered, without special articles of association, by Bowman and Co., 21, Bedford Row. Registered office, 6, White Hart Street, Paternoster Square.

Chagford and Devon Electric Light Company, Limited.—Capital £2,000 in £1 shares. Objects: To carry out an agreement of 12th inst. for supplying electric light to Chagford, Devon. Signatories: J. Collins, F. Aggett, J. Underhill, L. Holmes, J. Smith, 1 share each; G. H. Reed (engineer), 5 shares, all of Chagford, Devon; E. Eaton, C.E., M.S.A., 27, Martin's Lane, London, E.C., 1 share. Registered 18th inst., without special articles of association, by J. Fleming, 27, Martin's Lane, E.C.

Anglo-Mexican Saw Mills Company, Limited.—Capital £5,000, in £1 shares. Objects: To carry on in Mexico the business of saw mill proprietors, and to acquire all necessary rights of using steam, electricity, or water power in connection therewith, and particularly to manufacture cigar boxes; to acquire and deal with patent machinery, apparatus and materials for the production and distribution of electricity. Signatories (with 1 share each), H. S. Sugden, Stroud Green, N.; F. H. Depree, 21, George Street, Portman Square; T. Seabrook, 126, Stanstead Road, Forest Hill; W. Hart, 27, Sandover Road, Camberwell; G. H. Lovell, Manor Road Leyton; A. Allwork, 229, Tufnell Park Road, N. The signatories are to appoint the first directors. Qualification, 10 shares. The company, in general meeting, will determine remuneration. Registered 14th. Solicitor, Mr. James Curtis, 1, Old Jewry Chambers.

Ernest Scott and Mountain, Limited. — Capital, £70,000 in £10 shares. Objects: To carry on business as electrical and general engineers. Signatories (with 1 share each): P. W. Bullock, 19, Portsea Place, Connaught Square; J. Aspinall, 34, Bourvan's Buildings, Edgware Road; J. McNab, Drapers' Gardens; W. Capel Slaughter, 21, Great Winchester Street; D. Scott, 12, York Street, Manchester; A. H. Bartlett, 21, Great Winchester Street; S. E. Preston, 21, Great Winchester Street. The signatories are to appoint the first directors; qualification, £1,000 in shares; remuneration, £200 per annum to each ordinary director. Registered 17th inst. by Slaughter and May, 21, Great Winchester Street.

South Molton Shirt and Collar Manufacturing Company, Limited.—Capital £5,000 in £10 shares. Objects: To manufacture shirts, collars and cuffs. To act as undertakers for the supply of electricity for lighting and other purposes. Signatories: W. J. Redler, Taunton, 35 shares; W. C. Rafarel, Barnstaple, 20 shares; D. J. C. Bush, South Molton, 10 shares; G. H. Crocker, South Molton, 10 shares; J. T. B. White, South Molton, 5 shares; D. B. Redler, Taunton, 5 shares; G. Bush, 34, Cleveland Square, Hyde Park, 10 shares. The signatories are to nominate the first directors; qualification £50 in shares. Registered 17th inst. by Riccard and Son, South Molton, North Devon.

Electrolytic Syndicate, Limited.—Capital £100,000, in £1 shares. Objects: To adopt the following agreements, particulars of which are not specified, viz.:—An agreement of 25th ult., between Wm. Elmore and Alfred Wells; an agreement of 24th ult., between Arthur Cooper and Alfred Wells; an agreement of 25th ult., between John Fraser and Alfred Wells; an agreement of 23rd ult., between Woodhouse and Rawson United, Limited, of the first part, Wm. Elmore, Frank Elmore, and Alexander Stanley Elmore, of the second part, and Alfred Wells, of the third part. To carry on business as miners, metallurgists, smelters, and electricians. Signatories (with 1 share each): J. Jepson Atkinson, Cosgrave Priory, North Hants; W. Elmore, 47, Clapham Road; J. Thompson Cooper, Nightingale Lane, S.W.; F. Safford, 2, Garden Court, Temple; S. Evans, Lonsdale Chambers, Chancery Lane; W. J. H. Tippitt, 11, Maiden Lane; W. J. Peck, Redcar. Registered 17th inst., without articles by the Metropolitan Provisional Syndicate, Limited, 27, Chancery Lane.

CITY NOTES, REPORTS, MEETINGS, &c.

The Swan United Electric Light Company, Limited.

THE eighth annual report of the directors, to be presented at the ordinary general meeting of the company next Tuesday, states that after paying all current charges, and making due allowance for depreciation, there is a credit balance of £44,477 15s. 10d. The directors recommend that out of this balance a dividend of 10 per cent. for the year be declared; an interim dividend at the rate of 6 per cent. per annum, amounting to £11,104 0s. 5d., has already been paid in respect to the first half of the year; the balance of the 10 per cent. for the entire year to be distributed in accordance with clause 77 of the articles of association, and to be payable on the 1st December next. This will absorb £24,921 17s. 7d., and leave £8,451 17s. 10d. to be carried forward.

The decision in the patent suit in Germany was given in favour of this company in the Court of Appeal in Berlin during the summer. The Allgemeine Electricitäts Gesellschaft have appealed from that decision to the Sureme Court at Leipsic. It is expected that the case will be heard and finally decided before Christmas.

The Compagnie Générale des Lampes Incandescentes in Paris have not yet been able to obtain a decision in the courts on the validity of their French patents, but they think that the case will be reached and a decision given during next spring. Their business is increasing, but the competition which they have to sustain compels them to sell lamps at a lower price than heretofore.

The directors who retire by rotation are F. R. Leyland, Esq., and W. C. Quilter, Esq., M.P., who, being eligible, will offer themselves for re-election.

Messrs. Welton, Jones & Co., the auditors, will also retire, and will offer themselves for re-election.

The Allgemeine Elektricitaets-Gesellschaft.

A REPORT and balance-sheet for the financial year 1889-90 has just been issued, which will be presented to the general meeting on the 29th inst. The document before us reveals a most satisfactory state of affairs of this company, which has been in existence for about eight years, and which may be regarded as the most prosperous concern of the kind in Europe.

The sales of electrical supplies reached the large figure of £550,000, as against £300,000 during the previous year, an increase in trade of over 45 per cent. The company employs a staff of 400 officials and 1,600 workmen. In view of this enormous development of business, it was decided to increase the capital from £800,000 to £1,000,000 (20 marks taken as equivalent to £1). The company has recently acquired the Sprague system of electric traction, which is now being put into operation on the Halle tramways. Among other industrial undertakings in which the Allgemeine Electricitaets-Gesellschaft is largely interested, may be mentioned the works of Messrs. Muller and Einbeck, where the accumulators of Tudor are being manufactured; a considerable share in the Edison General Electric Company of New York; the large brass foundry of Messrs. J. C. Spinn and Son, of Berlin; the Berlin Elektricitaets-Werke (central station); the Compagnie Internationale d'Electricité of Liège; the Aluminium Company at Neuhausen; the Key's Electric Company, Limited, of London; the Syndicate for Exploitation of the Waterpower of the River Rhine; the Compania General Madrilena de Electricidad, Madrid (central station, with 20,000 lamps).

Among the patents which this company has purchased from time to time are those of Maxim-Weston, Sprague and Edison, in addition to a large number of Continental ones. The cost of these has been written off year after year, and this item is now credited in the balance-sheet with one shilling; the sum written off last year amounting to £5,366.

The net trading profits of 1889-90 stand at £63,639, against £39,573 last year, but the net profits from all sources reached the respectable total of £113,101, which will be distributed as follows:

Returnable	£7,500
Extraordinary reserve	12,500
10 per cent. dividend on £800,000 ...	80,000
Board of directors	8,000
Sick fund and pensions	4,000
Carried forward, 1890-91	1,101
	£113,101

The company proposes to take part in the next Frankfort Exhibition in a peculiar way; it intends to transmit to this city 300 H.P. of a waterfall 110 miles distant, the work to be carried out in conjunction with the Oerlikon Fabrik.

This is one of the most interesting reports to shareholders we have yet seen.

Blackpool Electric Tramway Company, Limited.

IN the report to be presented at the sixth annual general meeting, to be held to-morrow (Saturday), the directors state that they have pleasure in submitting to the shareholders their sixth report and the accompanying statement of the accounts of the company for the year ending 31st October, 1890.

The revenue account shows a balance in hand for the year of £2,455 9s. 3d. Adding to this £231 5s. 10½d. from last year, makes an available amount of £2,686 15s. 1½d., of which the directors recommend the following disposal:—

	£	s.	d.
Dividend of 7½ per cent. on the called up share capital, free of tax	1,501	17	6
Depreciation and reserve fund	1,000	0	0
Balance to next year's account	184	17	7½
	£2,686	15	1½

The depreciation and reserve fund, with the addition of £1,000 as above recommended, will be £4,418 15s. 1d.

The number of passengers carried this year was 812,299. The number of miles run during the year was about 92,000.

The retiring directors are Messrs. Ormerod, Shaw and Smith, who are eligible for re-election.

Mr. Broadbent's services as managing director have been secured again for the coming year.

The transfer books of the company will be closed from the 13th to the 22nd November, inclusively.

Eastern Extension Telegraph Company.

SIR JOHN PENDER presided on Wednesday afternoon at the offices, Winchester House, Old Broad Street, over an extraordinary general meeting of the shareholders of the Eastern Extension, Australasia, and China Telegraph Company, Limited.

The Chairman proposed the confirmation of the resolution passed at the meeting on the 22nd ult., and given in our issue of October 24th, for authorising the board from time to time to create and issue mortgage debenture stock of the company to an amount not exceeding one-third of the share capital for the time being issued and paid up, the stock to rank *pari passu* as a first charge on the undertaking and revenue of the company. The object of the meeting was, he said, to enable the directors to replace the £320,000 of 6 per cent. debentures by an issue of 4 per cent. debenture stock. This would effect a saving of £6,000 a year to the company.

The Marquis of Tweeddale seconded the motion.

Replying to questions, the Chairman said that they proposed to take 5 per cent. on application, 5 per cent. on allotment. and 90 per cent. on the 15th January. The 1st of February was the day on which they would be obliged to have the money ready to redeem the 6 per cent. bonds.

The motion was unanimously confirmed.

The Chairman afterwards observed that the present was rather an unfortunate time for the operation, but he thought they might congratulate themselves upon the fact that during all the existing exceptionally severe crisis their stocks had not varied ¼ per cent. Their proprietary, however, was one which was pretty free from Stock Exchange difficulties—persons having homes and dependent on small incomes, and who were able to appreciate steady and regular dividends.

A vote of thanks to the chairman closed the meeting.

Paris Edison Company.—The Edison Company of Paris, which has a share capital of 10 million francs, made a gross profit of 1,082,922 francs for the year 1889-90, and a net profit of 350,264 francs. A dividend of 22½ francs was declared on the original shares, and 4¾ francs on the new shares.

The Electric Construction Corporation, Limited.—Subject to final audit, the directors of the above company have decided to declare a dividend of 6 per cent. per annum upon the ordinary share capital of the corporation for the past year.

Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.—The transfer books will be closed from December 1st to December 8th inclusive, for the purpose of paying a dividend.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 14th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,087.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending November 14th were £5,240.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (November 13).	Closing Quotation. (November 20.)	Business done during week ending November 20, 1890.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	99 —102	97 —100	102	99
1,549,160*l*	Anglo-American Telegraph, Limited	Stock	49 — 50	48 — 49	49½	48⅞
2,725,420*l*	Do. do. 6 p. c. Preferred	Stock	85 — 86	84 — 85	85½	84¼
2,725,420*l*	Do. do. Deferred	Stock	13 — 13½	12¾— 13¼	13⅜	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¼— 11¾	10¾— 11¼	11⅝	$11\frac{5}{16}$
84,500*l*	Do. do. 5 p. c. Bonds...	100	101 —103	101 —103		
75,000*l*	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 —108	104 —108		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	1¼— 1¾	1¼— 1¾		
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1½— 2	1½— 2		
$7,216,000	Commercial Cable, Capital Stock	$100	102 —104	102 —104	103½	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	½— ⅝	$\frac{7}{16}$— $\frac{9}{16}$		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5¾	5¼— 5¾		
16,000	Cuba Telegraph, Limited	10	11½— 12	11½— 12	12	11⅛
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	18	17
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼		
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½— 9½		
60,710	Direct United States Cable, Limited, 1877	20	10 — 10¼	9⅞— 10⅛	10¼	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13⅝— 13⅞	13⅝— 13⅞		
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14¾— 15¼	14½	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 —109	106 —109	106½	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	103 —106	103 —106	105½	105
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13⅞— 14⅛	13¾— 14	14⅛	14
320,000*l*	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	100 —102		
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326	100	102 —105	102 —105		
325,200*l*	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105		
145,300*l*	Eastern and South African Tel., Ld., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104		
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 —104	101 —104		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7¾— 8¼	8 — 8½	8¼	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼		
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	4¼— 4¾	3¾— 4¼	4¼	4
67,385	Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid)	2	1¾— 2¼	1¾— 2¼		
20,000	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£4 only paid)	5	2½— 3½	2½— 3½		
180,227	Globe Telegraph and Trust, Limited	10	8⅞— 9⅛	9 — $8\frac{13}{16}$	8⅞	8⅝
180,042	Do. do. 6 p. c. Preference	10	14¾— 15	14¾— 14½		
150,000	Great Northern Tel. Company of Copenhagen	10	15¾— 16¼	15¾— 16¼	16¼	16
15,000*l*	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	101 —104	101 —104		
230,000*l*	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	11½— 12½	11½— 12½		
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½— 12½	11½— 12½		
41,609	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18 — 19	18 — 19	18¾	18½
200,000*l*	Do. do. 4½ p. c. Deb., 1896...	100	100 —102	100 —102		
17,000	Indo-European Telegraph, Limited...	25	35 — 37	35 — 37		
11,334	International Okonite, Ltd, Ordinary Nos. 22,667 to 34,000 (£7 pd.)	10	6½— 7½	6½— 7		
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6½— 7½	6½— 7		
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6 — 7		
100,000*l*	Do. do. do. 6 p. c. Debentures ...	100	105 —108	105 —108		
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5½— 6	6¼— 6¾	6⅛	...
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4⅛— 4⅜	4⅛— 4⅜	4½	$4\frac{5}{16}$
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12¼— 12¾		
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½— 10½	9½— 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	⅛— ⅜	⅛— ⅜		
9,000	Reuter's, Limited	8	8¼— 8¾	8¼— 8¾		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½— 3	2½— 3		
3,381	Submarine Cables Trust	Cert.	113 —117	113 —117		
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5 — 5½	5 — 5½	5¼	...
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	45	44½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102	100 —102	100½	..
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4		
146,128*l*	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 95		
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½— 9½	8½— 9½		
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101		
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5		
150,000*l*	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	102 —107	102 —107		
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	10½— 11	11¼	10⅝
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6⅝— 6⅞	6⅝— 6⅞	6⅞	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4½— 5	4⅞	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910...	100	103 —106	103 —106		
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	103	...
88,321	West India and Panama Telegraph, Limited	10	3⅛— 3⅜	3 — 3¼	$3\frac{1}{16}$	$2\frac{15}{16}$
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12	11¼— 11¾	11⅝	11¼
4,669	Do. do. do, 6 p. c. 2nd Preference ...	10	14 — 15	11 — 12		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —127	120 —125		
175,100	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ 3	2½— 3		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7 —7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 2—2¼.—House-to-House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2¼—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/- —13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2¼- ¾.—Preference, 4⅜—4⅝.

BANK RATE OF DISCOUNT.—6 per cent. (7th November 1890).

THE ELECTRO-MAGNET.*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(*Continued from page* 603.)

LECTURE III.—DELIVERED FEBRUARY 3RD, 1890.

SPECIAL DESIGNS.

In continuation of my lecture of last week, I have to make a few remarks before entering upon the consideration of special forms of magnets, which was to form the entire topic of to-night's lecture. I had not quite finished the experimental results which related to the performance of magnets under various conditions. I had already pointed out that where you require a magnet simply for holding on to its armature, common sense (in the form of our simplest formula) dictated that the circuit of iron should be as short as was compatible with getting the required amonnt of winding upon it. That at once brings us to the question of the difference in performance of long magnets and short ones. Last week we treated that topic so far as this, that if you require your magnet to attract over any range across an air space, you required a sufficient amount of exciting power in the circulation of electric current to force the magnetic lines across that resistance, and therefore you required length of core in order to get the required coil wound upon the magnetic circuit. But there is one other way in which the difference of behaviour between long and short magnets—I am speaking of horse-shoe shapes—comes into play. So far back as 1840, Ritchie found that it was more difficult to magnetise steel magnets (using for that purpose electro-magnets to stroke them with) if those electro-magnets were short than if they were long. He was, of course, comparing magnets which had the same tractive power, that is to say, presumably had the same section of iron magnetised up to the same degree of magnetisation. This difference between long and short cores is obviously to be explained on the same principle as the greater projecting power of the long-legged magnets. In order to force magnetism not only through an iron arch but through whatever is beyond, which has a lesser permeability for magnetism, whether it be an air gap or an arch of hard steel destined to retain some of its magnetism, you require magnetomotive force enough to drive the magnetism through that resisting medium; and, therefore, you must have turns of wire; that implies that you must have length of leg on which to wind those turns. Ritchie also found that the amount of magnetism remaining behind in the soft iron arch, after turning off the current, at the first removal of the armature, was a little greater with long than with short magnets; and, indeed, it is what we should expect now, knowing the properties of iron, that long pieces, however soft, retain a little more—have a little more memory, as it were, of having been magnetised—than short pieces. Later on I shall have specially to draw your attention to the behaviour of short pieces of iron which have no magnetic memory.

WINDING OF THE COPPER.

I now take up the question of winding the copper wire upon the electro-magnet. How are we to determine beforehand the amount of wire required, and the proper gauge of wire to employ?

The first stage of such a determination is already accomplished; we are already in possession of the formulæ for reckoning out the number of ampère tnrns of excitation required in any given case. It remains to show how from this to calculate the amount of bobbin space, and the quantity of wire to fill it. Bear in mind that a current of ten ampères (*i.e.*, as strong as that used for a big arc light) flowing once around the iron, produces exactly the same effect magnetically as a current of one ampère flowing around ten times or as a current of only one-hundredth part of an ampère flowing around a thousand times. In telegraphic work the currents ordinarily used in the lines are quite small, usually from five to twenty thousandths of an ampère; hence in such cases the wire that is wound on need only be a thin one, but it must have a great many turns. Because it is thin and has a great many turns, and is consequently a long wire, it will offer a considerable resistance. That is no advantage, but does not necessarily imply any greater waste of energy than if a thicker coil of fewer turns were used with a correspondingly larger current. Consider a very simple case. Suppose a bobbin is already filled with a certain number of turns of wire, say 100, of a size large enough to carry one ampère, without over-heating. It will offer a certain resistance, it will waste a certain amount of the energy of the current, and it will have a certain magnetising power. Now suppose this bobbin to be re-wound with a wire of half the diameter; what will the result be? If the wire is half the diameter it will have one quarter the sectional area, and the bobbin will hold four times as many turns (assuming insulating materials to occupy the same percentage of the available volume). The current which such a wire will carry will be one-fourth as great. The coil will offer sixteen times as much resistance, being four times as long and of one-fourth the cross section as the other wire. But the waste of energy will be the same, being proportional to the resistance and to the square of the current; for $16 \times \frac{1}{16} = 1$. Consequently the heating effect will be the same. Also the magnetising power will be the same, for though the current is only one-quarter of an ampère, it flows around four hundred turns; the ampère turns are one hundred, the same as before. The same argument would hold good with any other numerical instance that might be given. It therefore does not matter in the least to the magnetic behaviour of the electromagnet whether it is wound with thick wire or thin wire, provided the thickness of the wire corresponds to the current it has to carry, so that the same number of watts of power are spent in heating it. For a coil wound on a bobbin of given volume the magnetising power is the same for the same heat waste. But the heat waste increases in a greater ratio than the magnetising power, if the current in a given coil is increased; for the heat is proportional to the square of the current and the magnetising power is simply proportional to the current. Hence it is the heating effect which in reality determines the winding of the wire. We must—assuming that the current will have a certain strength—allow enough volume to admit of our getting the requisite number of ampère turns without overheating. A good way is to assume a current of one ampère while one calculates out the coil. Having done this, the same volume holds good for any other gauge of wire appropriate to any other current. The terms "long-coil" magnet and "short-coil" magnet are appropriate for those electromagnets which have, respectively, many turns of thin wire and few turns of thick wire. These terms are preferable to "high resistance" and "low resistance," sometimes used to designate the two classes of windings, because, as I have just shown, the resistance of a coil has in itself nothing to do with its magnetising power. Given the volume occupied by the copper, then for any current density (say, for example, a current density of 2,000 ampères per square inch of cross section of the copper), the magnetising power of the coil will be the same for all different gauges of wire. The specific conductivity of the copper itself is of importance; for the better the conductivity, the less the heat waste per cubic inch of winding. High conductivity copper is therefore to be preferred in every case.

Now the heat which is thus generated by the current of electricity raises the temperature of the coil (and of the core), and it begins to emit heat from its surface. It may be taken as a sufficient approximation that a single square inch of surface, warmed 1° Fahr. above the surrounding air, will steadily emit heat at the rate of $\frac{1}{225}$ of a watt. Or, if there is provided only enough surface to allow of a steady emission of heat at the rate of 1 watt* per sq. inch of surface, the temperature of that surface will rise to about 225° Fahr. above the temperature of the surrounding air. This number is determined by the average emissivity of such substances as cotton, silk, varnish, and other materials of which the surfaces of coils are usually composed.

In the specifications for dynamo machines, it is usual to lay down a condition that the coils shall not heat more than a certain number of degrees warmer than the air. With electro-magnets it is a safe rule to say that no electro-magnet ought ever to heat up to a temperature more than 100° Fahr. above the surrounding air. In many cases it is quite safe to exceed this limit.

The resistance of the insulated copper wire on a bobbin may be approximately calculated by the following rule. If d is the diameter of the naked wire, in mils, and D is the diameter, in mils, of the wire when covered, then the resistance per cubic inch of the coil will be:—

$$\text{Ohms per cub. inch} = \frac{960{,}700}{D^2 + d^2}.$$

We are therefore able to construct a wire gauge and ampèrage table which will enable us to calculate readily the degree to which a given coil will warm when traversed by a given current, or conversely what volume of coil will be needed to provide the requisite circulation of current without warming beyond any prescribed excess.

Accordingly, I here give a *Wire-Gauge and Ampèrage Table*, which we have been using for some time at the Finsbury Technical College. It was calculated out under my instructions by one of the Demonstrators of the College, Mr. Eustace Thomas, to whom I am indebted for the great care bestowed upon the calculations.

For many purposes, such as for use in telegraphs and electric bells, smaller wires than any of those mentioned in the table are required. The table is, in fact, intended for use in calculating magnets in larger engineering work.

A rough and ready rule sometimes given for the size of wire is to allow $\frac{1}{1000}$ square inch per ampére. This is an absurd rule, however, as the figures in the table show. Under the heading 1,000 ampères to square inch, it appears that if a No. 18 S.W.G. wire is used, it will at that rate carry 1·81 ampères; that if there is only one layer of wire, it will only warm up 4·64° Fahr., consequently one might wind layer after layer to a depth of 3·3 inches, without getting up to the limit of allowing one square inch per watt, for the emission of heat. In very few cases does one want

---

* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

* The *watt* is the unit of rate of expenditure of energy, and is equal to ten million ergs per second, or to $\frac{1}{746}$th of a horse-power. A current of one ampère, flowing through a resistance of one ohm, spends energy in heating at the rate of one watt. One watt is equivalent to 4·2 calories per second, of heat. That is to say, the heat developed in one second, by expenditure of energy at the rate of one watt, would suffice to warm one gramme of water through 4·2 (Centigrade) degrees. As 252 calories are equal to one British (lb. Fahrenheit) unit of heat, it follows that heat emitted at the rate of one watt would suffice to warm 17½ pounds of water one degree Fahrenheit in one minute; or one British unit of heat equals 1,058 watt-seconds.

TABLE X.—WIRE GAUGE AND AMPERAGE TABLE.

Dimensions.					Permissible ampèrage, probable heating, and permissible depth.											
S.W.G.	Diam. (inch.)	Section. (sq. inch bare.)	Turns to 1 linear inch. (coverd.)	Turns per sq. inch. (coverd.)	At 1,000 amps. to sq. inch.			At 2,000 amps. to sq. inch.			At 3,000 amps. to sq. inch.			At 4,000 amps. to sq. inch.		
					A	F	D	A	F	D	A	F	D	A	F	D
22	·028	·00062	23·81	624·	·616	2·28	4·5	1·23	9·12	1·13	1·85	20·52	·50	2·46	36·5	·28
20	·036	·0010	20·00	440·	1·018	3·18	3·9	2·036	12·72	·97	3·05	28·62	·43	4·07	50·9	·24
19	·040	·0012	18·52	377·	1·26	3·56	3·6	2·52	14·24	·92	3·78	32·04	·41	5·04	57·0	·23
18	·048	·0018	16·13	286·	1·81	4·64	3·3	3·62	18·56	·83	5·43	41·76	·37	7·24	74·2	·21
17	·056	·0024	14·28	224·	2·4	5·47	3·2	4·8	21·9	·79	7·2	49·2	·35	9·6	87·5	·19
16	·064	·0032	12·83	181·	3·2	6·57	3·0	6·4	26·3	·74	9·6	59·1	·33	12·8	105·1	·18
15	·072	·0040	11·63	149·	4·0	7·40	2·9	8·0	29·6	·72	12·0	66·6	·32	16·0	118·4	·17
14	·080	·0050	10·64	124·	5·0	8·46	2·8	10·0	33·8	·70	15·0	76·3	·31	20·0	135·4	·17
13	·092	·0060	9·44	98·2	6·6	9·97	2·7	13·2	39·9	·67	19·8	89·7	·30	26·4	159·5	·16
12	·104	·0085	8·48	79·1	8·5	11·53	2·6	17·0	46·1	·65	25·5	103·8	·29	34·0	184·4	·16
11	·116	·0105	7·69	65·0	10·5	12·8	2·5	21·0	51·2	·63	31·5	115·2	·28	42·0	204·8	·16
10	·128	·0128	7·04	54·5	12·8	14·3	2·4	25·6	57·2	·61	38·4	128·7	·27	51·2	228·8	·15
9	·144	·0163	6·33	44·1	16·3	16·4	2·4	32·6	65·6	·60	48·9	147·6	·27	65·2	262·4	·15
8	·160	·0201	5·74	36·3	20·1	18·4	2·3	40·2	73·6	·59	60·3	165·6	·26	80·4	294·4	·15
7	·176	·0243	5·26	30·4	24·3	20·4	2·3	48·6	81·6	·58	72·9	183·6	·26	97·2	326·4	·15
Stranded.																
7/22	0·84	·0043	9·62	101·8	4·3	6·73	4·0	8·6	26·9	·99	12·9	24·6	·44	17·2	107·7	·25
7/20	·108	·0072	7·81	67·1	7·13	8·94	3·7	14·3	35·7	·92	21·4	80·5	·48	28·5	143·0	·23
7/18	·144	·0128	6·09	40·8	12·7	12·4	3·4	25·4	49·6	·83	38·1	111·6	·39	50·8	198·4	·21
7/16	·192	·0229	5·10	28·6	22·9	17·2	3·2	45·8	68·7	·79	68·7	154·5	·35	91·6	274·7	·20
7/15	·216	·0289	4·27	20·1	28·9	19·5	3·1	57·8	78·0	·78	86·7	175·4	·34	115·6	311·8	·20
7/14	·240	·0356	3·87	16·5	35·6	21·8	3·1	71·2	87·1	·76	106·8	195·9	·34	142·4	348·3	·19
7/13	·276	·0462	3·38	12·6	46·2	24·7	3·0	92·4	98·8	·74	138·6	222·3	·33	184·8	395·2	·19
7/12	·312	·0595	3·01	9·97	59·5	28·5	2·9	179·0	114·0	·72	178·5	256·5	·32	238·0	456·	·18

Figures in columns marked A signify number of ampéres that the wire carries.

Figures in columns marked F signify number of degrees (Fah.) that the coil will warm up if there is only one layer of wire, and on the assumption that the heat is radiated only from the outer surface of the coil: they are calculated by the following modification of Forbes's rule:—

Rise in temperature (Fahrenheit degrees)

= 225 × No. of watts lost per sq. inch.
= 159 × sectional area × number of turns to 1 inch (at 1,000 amps. per sq. inch).

Figures in columns marked D are the depths in inches to which wire may be wound if one watt be lost by each square inch of radiating surface, the outside radiating surface of the bobbin being only considered.

Rule for calculating a 7-strand cable:—Diam. of cable = 1·134 × by diam. of equivalent round wire.

Figures under heading "Turns to 1 linear inch" are calculated for cotton-covered wires of average thicknesses of coverings used for the different gauges, viz., 14 mils additional diameter on round wires (from No. 22), and 20 mils on stranded or square wire.

Figures under heading "Turns per sq. inch" are calculated from preceding, allowing 10 per cent. for bedding of layers.

Resistance (ohms) of coil of copper wire, occupying v cubic inches of coil-space, and of which the gauge is d mils uncovered, and D mils covered, may be approximately calculated by the rule:—

$$\text{ohms} = 960{,}700\,\frac{v}{\mathrm{D}^2\,d^2}.$$

The data respecting sizes of wires of various gauges are kindly furnished by the London Electric Wire Company.

to wind a coil so thick as 3·3 inches. For very few electro-magnets is it needful that the layer of coil should exceed ½ an inch in thickness; and if the layer is going to be only ½ an inch thick, or about $\frac{1}{7}$th of the 3·3, one may use a current density $\sqrt{7}$ times as great as 1,000 ampères per square inch, without exceeding the limit of safe working. Indeed, with coils only ½ inch thick, one may safely employ a current density of 3,000 ampères per square inch, owing to the assistance which the core gives for the dissipation and emission of heat.

Suppose, then, we have designed a horse-shoe magnet, with a core 1 inch in diameter, and that after considering the work it has to do, it is found that a magnetising power of 2,400 turns is required; suppose, also, that it is laid down as a condition that the coil must not warm up more than 50° Fahr. above the surrounding air—what volume of coil will be required? Assume first that the current will be 1 ampère; then there will have to be 2,400 turns of a wire which will carry 1 ampère. If we took a No. 20 S.W.G. wire, and wound it to a depth of ½ an inch, that would give 220 turns per inch length of coil: so that a coil 11 inches long, and a little over ½ inch deep (or 10 layers deep) would give 2,400 turns. Now Table X. shows that if this wire were to carry 1·018 ampère, it would heat up 225° Fahr., if wound to a depth of 3·9 inches. If wound to ½ inch, it would therefore heat up about 30° Fahr.; and with only 1 ampère would of course heat less. This is too good; try the next thinner wire. No. 22, S.W.G. wire, at 2,000 ampères to square inch, will carry 1·23 ampères; and heats 225° if wound up 1·13 inches. If it is only to heat 50° it must not be wound more than ¼ inch deep; but if it only carries current of 1 ampère it may be wound a little deeper—say to 14 layers. There will then be wanted a coil about 7 inches long to hold the 2,400 turns. The wire will occupy about 3·85 square inches of total cross section; and the volume of the space occupied by the winding will be 26·95 cubic inches. Two bobbins, each 3½ inches long and ·65 deep, to allow for 14 layers, will be suitable to receive the coils.

By the light of the knowledge one possesses as to the relation between emissivity of surface, rate of heating by current, and limiting temperatures, it is seen how little justification there is for such empirical rules as that which is often given, namely, to make the depth of coil equal to the diameter of the iron core. Consider this in relation to the following fact; that in all those cases where leakage is negligible, the number of ampère turns that will magnetise up a thin core to any prescribed degree of magnetisation will magnetise up a core of any section whatever, and of the same length, to the some degree of magnetisation. A rule that would increase the depth of copper proportionately to the diameter of the iron core is absurd.

Where less accurate approximations are all that is needed, more simple rules can be given. Here are two cases:—

Case 1. *Leakage assumed to be negligible.*—Assume $\mathsf{B} = 16{,}000$, then $\mathsf{H} = 50$ (see Table III). Hence the ampère turns per centim. of iron will have to be 40, or per inch of iron, 102; for H is equal to 1·2566 times the ampère turns per centimetre. Now if the winding is not going to exceed ½-inch in depth, we may allow 4,000 ampères per square inch without serious overheating. And the 4,000 ampère turns will require 2-inch length of coil, or each inch of coil carries 2,000 ampère turns without overheating. Hence each inch of coil ½-inch deep will suffice to magnetise up 20 inches length of iron to the prescribed degree.

Case 2. *Leakage assumed to be* 50 *per cent.*—Assume B in air gap $= \mathsf{H} = 8{,}000$, then to force this across requires ampère turns 6,400 per centim. of air, or 16,250 per inch of air. Now if winding is not going to exceed ½-inch depth, each inch length of coil will carry 2,000 ampère turns. Hence, 8 inches length of coil ½-inch deep will be required for one inch length of air, magnetised up to the prescribed degree.

WINDINGS FOR CONSTANT PRESSURE AND FOR CONSTANT CURRENT.

In winding coils for magnets that are to be used on any electric light system, it should be carefully borne in mind that there are separate rules to be considered according to the nature of the supply. If the electric supply is at *constant pressure*, as usual for glow lamps, the winding of coils of electro-magnets follows the same rule as the coils of voltmeters. If the supply is with *constant current*, as usual for arc lighting in series, then the coils must be wound with due regard to the current which the wire will carry, when lying in layers of suitable thickness, the number of turns being in this case the same whether thin or thick wire is used.

If we assume that a safe limit of temperature is 90° Fahr. higher than the surrounding air, then the largest current which may be used with a given electro-magnet is expressed by the formula:—

$$\text{Highest permissible ampères} = 0{\cdot}63\sqrt{\frac{s}{r}}$$

where s is the number of square inches of surface of the coils, and r their resistance in ohms.

Similarly for coils to be used as shunts we have :—

$$\text{Highest permissible volts} = 0{\cdot}63\sqrt{s\,r}$$

The magnetising power of a coil, supplied at a given number of volts of pressure, is independent of its length, and depends only on its gauge, but the longer the wire the *less* will be the heat waste. On the contrary, when the condition of supply is with a constant number of ampères of current, the magnetising power of a coil is independent of the gauge of the wire, and depends only on its length; but the larger the gauge the less will be the heat waste.

MISCELLANEOUS RULES ABOUT WINDING.

To reach the same limiting temperature with bobbins of equal size wound with wires of different gauge, the cross-section of the wire must vary with the current it is to carry; or, in other words, the current density (ampères per square inch) must be the same in each. Table X. shows the amperages of the various sizes of wires, at four different values of current density.

To raise to the same temperature two similarly shaped coils, differing in size only, and having the gauges of the wires in the same ratio (so that there are the same number of turns on the large coil as on the small one), the currents must be proportional to the square roots of the cubes of the linear dimensions.

Sir William Thomson has given a useful rule for calculating windings of electro-magnets of the same type but of different sizes. Similar iron cores, similarly wound with lengths of wire proportional to the squares of their linear dimensions, will, when excited with equal currents, produce equal intensities of magnetic field at points similarly situated with respect to them.

Similar electro-magnets of different sizes must have ampère-turns proportional to their linear dimensions if they are to be magnetised up to an equal degree of saturation.

It is curious what erroneous notions crop up from time to time about winding electro-magnets. In 1869, a certain Mr. Lyttle took out a patent for winding the coils in the following way. Wind the first layer as usual, then bring the wire back to the end where the winding began and wind a second layer, and so on. In this way all the windings will be right-handed, or else all left-handed, not alternately right and left as in the ordinary winding. Lyttle declared that this method of winding a coil gave more powerful effects; so did M. Brisson, who re-invented the same mode of winding in 1873, and solemnly described it. Its alleged superiority was at once disproved by Mr. W. H. Preece, who found the only difference to be that there was more difficulty in carrying out this mode of winding.

Another popular error is that electro-magnets in which the wires are badly insulated are more powerful than those in which they are well insulated. This arose from the ignorant use of electro-magnets having long thin coils (of high resistance) with batteries consisting of a few cells (of low electromotive force). In such cases, if some of the coils are short-circuited, more current flows, and the magnetising power may be greater. But the scientific cure is either to rewind the magnet with an appropriate coil of thick wire, or else to apply another battery having an electromotive force that is greater.

(*To be continued.*)

NEW PATENTS—1890.

17165. "A process for producing copper blocks with steel core for the manufacture of telegraph and telephone wire." H. LOHAUSEN. Dated October 27.

17181. "Improved electric switch." H. J. ALLISON. (Communicated by J. A. K. McGregor, H. Wallach, and S. J. Wallach, United States.) Dated October 28. (*Complete.*)

17247. "Improvements in electric apparatus for transmitting motion." M. W. DEWEY. Dated October 28. (*Complete.*)

17277. "An improved method of and apparatus for the electrical treatment of sewage, wines, oils, air, gases, and other fluids." R. WOTHERSPOON. (Communicated by H. Rowley, Australia.) Dated October 29.

17308. "Improved switch for electric light." C. W. COX and F. ROBINSON. Dated October 29.

17375. "An electric motor." J. B. DENIS. Dated October 30.

17394. "Apparatus for effecting a permanent make or break of an electric circuit at any suitable number of points." L. V. CHABRAND. Dated October 30.

17459. "Improvements in and relating to electric arc lamps." F. V. MAQUAIRE. Dated October 31.

17558. "Portable generator and electrometer for testing insulation resistance of electric wires." J. J. RATHBONE. Dated November 1.

17560. "Improvements in and relating to locked switches for electric current circuits." J. A. ILIFFE and H. BARTON. Dated November 1.

ABSTRACTS OF PUBLISHED SPECIFICATIONS 1889.

14860. "Improvements in automatic telephone devices." C. G. HOFFMANN. Dated September 20. 11d. Consists in the main of the speaking apparatus, of the mechanism for examining the coin and of the box, and consists in the combination of a telephone system with a coin examining apparatus and a clock mechanism situated in the exchange station in such a manner, that by the insertion of a certain coin into the apparatus a draw rod is released and by pulling the same by means of lever connections the telephones are liberated so that a call is automatically effected to the exchange station, which establishes the desired connection with the public speaking station which is then connected with the wire of the subscriber by the pressure of a button and at the same time causing the stoppage of a wheel moved by a clock mechanism during any desired interval (5 minutes) by a lever which at the termination of this time, raised by another lever, establishes again the earth connection and thus interrupts automatically the connection of the public speaking station with the subscriber. 6 claims.

15609. "Improved electrical railway switch and signal apparatus." F. X. BACHMANN. Dated October 4. 8d. Includes a system of signals electrically operated in conjunction with the points from the same station. 4 claims.

17124. "Improvements in interrupting devices for electric circuits, applicable for protecting electrical apparatus connected in such circuits." W. P. THOMPSON. (A communication from abroad by the Westinghouse Electric Company of America.) Dated October 29. 8d. Consists in forming a shunt circuit around a fusible strip, so constructed as to receive the entire current immediately upon the destruction of the fusible strip and then itself become interrupted in such a manner as to form an opening of the circuit. 3 claims.

17274. "An electric switch." G. S. GRIMSTON. (Partly communicated from abroad by F. Jacob.) Dated October 31. 6d. The inventor provides a ratchet wheel having an even number of teeth, which are alternately of conducting and of insulating material or are faced with such material, all the conducting parts being connected to the one wire of the circuit. A metallic spring pawl which is connected to the other wire of the circuit bears against the ratchet wheel, which is otherwise insulated from the pawl. On turning the wheel by hand partly round the pawl is first strained against its spring and then jumps rapidly from one tooth to the next, making or breaking contact as the case may be, and then holding the wheel steadily in position and preventing it from being turned backwards. 1 claim.

17694. "An electrical watt meter." E. WILSON. Dated November 6. 8d. The inventor applies an automatic break solenoid, excited by the current or a known fraction thereof, to give reciprocation to an anchor acting on an escapement wheel to cause a spindle to revolve at a speed which is proportional to the electromotive force or volts of the exciting current. The spindle drives a disc or cone, and also by means of a bevil wheel drives two opposite bevil pinions which are free on a transverse spindle, but either of which can be clutched to the transverse spindle by a clutch sleeve sliding between them. This clutch sleeve is connected to an armature between two electro-magnets, or to the core of a solenoid subject to the strain of a spring, so that according as the one or the other of the two electro-magnets is excited or according as the solenoid is excited or not, the clutch is moved so as to engage the one or the other of the two bevil pinions to the transverse spindle, causing that spindle to rotate in the one direction or the other. 2 claims.

17831. "Improvements in electric battery carbon and carbon compound elements and their connections." J. V. SHERRIN. Dated November 8. 6d. The inventor connects and prepares the carbon or carbon compound elements for primary and other electric batteries in the following manner: In that part of the upper edge of the carbon where the connection is to be made he laps it round with a piece of sheet platinum or platinum foil upon which he places a brass clamp or other connection for the wire. The clamp may be fixed by means of a screw the point of which bears on an interposed copper plate. To the clamp he connects the wire by soldering or by a terminal screw. The upper part of the carbon element is then covered with shellac to a depth of about an inch or two down from the top. 3 claims.

18159. "Improvements in electric contact apparatus, chiefly designed for indicating the level of water in reservoirs, the movement of hauling drums, lifts, and the like." C. WEUSTE. Dated November 13. 8d. Comprises a disc having in or upon it one or more teeth, which disc is in the first place caused to turn by the float of a water reservoir or by the machine or other device to be controlled. By this means a pin, acted upon by a weight or a comparatively heavy ball, is carried away. As soon as the aforesaid tooth has been turned far enough it releases the ball or the pin whereupon the latter by reason of its weight or the action of the spring will move upon a suitable guide back to its original position, making contact at the same time. 2 claims.

18980. "Improved means of suspending electric lamps and other suspended objects." W. F. BRADNER. Dated November 26. 8d. Consists in the interposition, in the suspension cord or cable, of a differential pulley, windlass, or drum having peripheries of two diameters, from one of which the cable extends to the ceiling or other point of support, and from the other of which the cord or cable descends to the lamp, the differential pulley (with or without a case) forming a weight which, when the lamp is lifted, gravitates, and in unrolling the cord from the smaller pulley rolls up the slack on to the larger pulley, the balancing effect of the two pulley surfaces serving to hold the lamp at any point to which it may be adjusted. 8 claims.

19195. "Improvements in and relating to the laying of electric and other wires in streets and roads." R. SUMMERS. Dated November 29. 6d. The inventor forms the curb of the pathway hollow and of suitable material, such as cast iron, the cross section being the same as the present curb but considerably deeper. The sections are made in suitable lengths and are jointed together in any known manner. Where the wires have to cross a road, elbows are provided so as to obtain the different level between the footpath and the roadway. Openings, closed by suitable lids or doors, are provided at suitable distances apart in order to allow of easily getting at the wires and suitable connections are provided to allow of the wires being conducted to the buildings in the street or road where required. 3 claims.

1890.

1878. "Improvements in electric insulating compounds." J. B. WILLIAMS. Dated February 4. 6d. Consists, briefly, in the combination with India-rubber and paraffin wax of a resinous body and sulphur, to which may be added what may be designated as inert material which serves to harden the compound and lessen its cost. 5 claims.

3484. "Improved electrical secondary clockwork." E. SCHWEIZER. Dated March 4. 6d. Consists in the employment of a lever to which a reciprocating motion is imparted by the combined influence of a horizontal electro-magnet and of a spring, and which on the one hand operates by means of a pawl upon a toothed wheel on the minute arbor, and on the other hand acts by means of a rod upon a special escapement device, which in its turn acts upon the said toothed wheel, so that the number of wheels of the electrical secondary clock can be limited to that of the minute and hour wheels of an ordinary clock dial. 2 claims.

3419. "Method of and apparatus for producing and utilising pulsating electric currents in closed circuits." C. J. VAN DEPOELE. Dated March 4. 11d. Comprises means for producing electric currents having a defined rise and fall being thereby rendered intermittent or pulsating, means for varying the rate of succession of said currents, together with both rotary and reciprocating engines particularly adapted to be operated with currents produced according to my said invention, the said defined currents being moreover utilised in closed working circuits so that their characteristic qualities are not due to the use of circuit-breaking devices, upon all of which my present invention is an improvement. 5 claims.

CORRESPONDENCE.

Alternating Current Meters.

In your issue of October 10th, I find a letter of Mr. Arthur Wright on the subject of alternating current meters, which, on account of the writer and the contents, I cannot pass without notice. You will greatly oblige me therefore, if you will kindly insert in your columns the following few lines.

I regret that various reasons prevent me to speak without restriction on the subject as I would desire, but perhaps few words will be sufficient to show Mr. Wright that he is unacquainted with the real state of the things.

My patents—it will be remembered—appeared 1st of May, 1888, and nearly at the same time the results of Prof. Ferraris were published in *Industries*, disclosing the same invention. Once the invention was known it required but little inventive spirit to make experiments and modifications, which sooner or later must suggest themselves to every intelligent worker, and it is needless to say that the experiments referred to by Mr. Wright were performed by me at a much earlier period, and an application covering broadly the principle of operating a motor by passing an alternating current through a circuit, and inducing currents by the same in other parts or closed circuits, was filed by me long before I read my paper and showed some of my motors before the American Institute of Electrical Engineers, in May 1888. I was, however, at that time, not at liberty to speak on this and other matters which would have rendered my paper more valuable and interesting.

Nothing was known through the journals of this invention until Schallenberger's patent on the meter appeared, I believe in June, 1888, where a motor on this principle was shown in combination with a registering and retarding device. Besides some forms of motors constructed by me and based on the principle of magnetic lag and screening—which were somewhat novel features—nothing new was shown in the way of a commutatorless motor, which would not be comprised within the scope of the inventions of Prof. Ferraris, Schallenberger and myself.

Mr. Wright states that I am wrong in attributing the rotation in his meter to the same cause as that in Schallenberger's. I have conceived the theory of these phenomena and confirmed it by many experiments. I have been familiar with them long in advance of anything published on that subject, and have utilised the principle underlying them in many forms of practical motors; I therefore think that I am not mistaken. In Schallenberger's meter a current is passed through one circuit and currents are induced in other circuits, and the poles are shifted; is not the same the case in Wright's meter? As regards the motive devices invented by Messrs. Borel and Piccaud, to which Mr. Wright refers, he makes me a high compliment, for motors on that principle were among the first which I have devised and operated, and not only have I devised many forms of these motors, but I have also shown, nearly three years ago, that in accordance with my theory of the action of the motors, a rotation in opposite direction may be produced under certain conditions.

Nikola Tesla.

November 7th, 1890.

High-handed Proceedings.

Mr. A. Erskine Muirhead has asked us to insert the following correspondence:—

Mr. James Richmond, Baker,
John Finnie Street, Kilmarnock.

22, Castle Street, Edinburgh,
4*th November*, 1890.

SIR,—We act for the United Telephone Company of London, and have to-day received instructions to adopt proceedings against your infringing certain patent rights belonging to them. We are informed that you have recently fitted up and are using four Ader receivers, which are infringements of their patent, and our instructions are forthwith to raise an action for interdict, damages, delivery of the instruments and costs. Before doing so, we write to give you intimation of this and an opportunity of delivering up the four infringing instruments. If these are delivered to us here *complete* in the course of *to-morrow*, we shall refrain from instituting legal proceedings. If they are not, proceedings will be at once instituted without further notice.

We also beg to request you to inform us who supplied you with the instruments; and, in your own interest, to warn you against delivering them over to any one except our clients or us.

We are, your obedient Servants,
DAVIDSON & SYME.

Glasgow, 6*th November*, 1890.

Messrs. Davidson and Syme,
22, Castle Street, Edinburgh.

Gentlemen,—Your favour of 4th inst., addressed to Mr. Jas. Richmond, Kilmarnock, has been handed to me, asking me to write you and also for my advice. I may at once say I take all responsibility upon myself, and when fitting up the telephones, told Mr. Richmond that they did not infringe any of the patents held by the National Telephone Coy., Ld., or the United Telephone Coy., Ld.; I again assert this. The telephone in question will not be removed nor handed to you, but to show that I am more magnanimous than your clients, I am willing to allow your electric engineer, Mr. Aitken, to go with my man and inspect the telephones for himself in your client's interest.

It will help to clear the matter when I inform you that they are the English type of telephones in French cases, and this is the reason, I presume, that your zealous employés jumped to the conclusion that they were the celebrated "Ader" telephones that have given your president, Col. Jackson, and William Alexander Smith, Esq., chairman of Local Board, so much anxiety of late. I hear that your employés entered the premises of Mr. Richmond; this, if not a criminal is an illegal act, and whether the telephones are infringements or not, it will fall to your party to conciliate Mr. Richmond in any case.

Your obedient servant,

A. ERSKINE MUIRHEAD.

P.S.—The telephones have Carta (paper) diaphragms, with ¼" iron armatures and electro-magnets. They have no permanent magnet nor iron diaphragms.

Glasgow, 10*th November*, 1890.

Messrs. Davidson & Syme,
22, Castle Street, Edinburgh.

Gentlemen,—Though I wrote you on the 6th curt., I am still without any reply from you or your clients, The National and United Telephone Company, Limited, as to what proposal they have to make regarding their unwarrantable proceedings in interfering with my telephones. I may add that I have consulted the highest authority on telephony in this country, viz., Mr. A. R. Bennett, late manager for Scotland for the National Telephone Coy., Ld.; you can consult him also, I presume.

Yours truly,

A. E. MUIRHEAD.

Glasgow, 11*th November*, 1890.

Messrs. Davidson and Syme, Edinburgh.

Gentlemen,—I am still without any reply from you, and as the idea is being spread abroad by your clients, that your clients seized four "Ader" receivers infringing your client's patents, as the said four telephones belong to me, and as before explained to Mr. Alexander Smith, chairman of the Local Board of the N. T. Company, Limited, in a letter dated 4th curt., of which the following is a copy:—

"*November* 4*th*, 1890.

"Mr. W. Alex. Smith,
"6, So. Hanover Street, Glasgow.

"Dear Sir,—I have your favour of date and am sorry you cannot accede to my request.* I am fitting a number of 'Ader' receiver cases with Carta and English Mechanic diaphragms for exposure in Glasgow and elsewhere. I presume you are aware that those do not infringe any of your patents. I shall have pleasure in giving your engineer an order to inspect them should he think fit.

"Signed A. ERSKINE MUIRHEAD."

Mr. W. A. Smith replies on 6th as follows from Telephone Office:—

Glasgow, *November* 6*th*, 1890.

A. Erskine Muirhead, Esq.,
Cart Forge, Glasgow.

Dear Sir,—On my return from England this morning I find your favour of 4th. As I mentioned to you formerly this company is determined to uphold its patents to the last day they run, and it is for you to act so that you do not infringe upon any of our rights. The question, what is or is not an infringement of our patent appliances, is one which the courts alone will decide.

Yours respectfully,

WM. ALEX. SMITH.

Up till this date you have not made any reply to my communications, you will not consider it out of order should I send a copy of this correspondence to the Press.

Yours truly,

A. E. MUIRHEAD.

P.S.—You will please note that I am running bronze wires in England and Scotland for some of the largest manufacturing firms, to which "Ader" telephones will be fixed on the expiry of the telephone patent which occurs in a few days now. To be above board with your clients, I am willing to give you a list of those lines, but repeat I will not remove the telephones in Kilmarnock.

Glasgow Offices, Royal Exchange Buildings,
11*th November*, 1890.

A. Erskine Muirhead, Esq.,
Cart Forge, Crossingloof.

Dear Sir.—Regarding yours of the 4th inst., to Mr. W. A. Smith, we have instructions from our London office for our Mr. Aitken to examine the instruments therein referred to. I will be glad therefore if you will let me know at what time it will be convenient for him to do so.

Yours truly,

F. DOUGLAS WATSON,
Assistant District Secretary.

Glasgow, *November* 12*th*, 1890.

The National Telephone Co., Ltd.,
Glasgow.

Gentlemen,—Your favour of the 11th is duly to hand, but as your Mr. Alexander Smith had already declined my offer to save you from the undignified position you have now placed yourselves in, not to speak of the position occupied by some of your employés, into whose conduct the criminal authorities are making investigation, it is for your London Office to adopt another mode of proceedure.

The instruments will be produced at the proper time and place for inspection by competent authorities.

Don't you think some apology is due to Mr. Richmond for your employés' proceedings?

Yours truly,

A. E. MUIRHEAD.

Note on Localisation of Faults in Electric Light Circuits.

The ELECTRICAL REVIEW of October 10th, 1890, describes M. Henri Wilbrant's test for localising an *earth* fault when this occurs in one of a pair of buried leads of equal length and resistance.

Fig. 1 shows M. Wilbrant's method:—Accumulator with one pole earthed joined up through ammeters to looped leads A and B. C^1 and C^2 are deflections on respective ammeters. L = total length, or total resistance of loop, and x = distance of fault from test station.

Then $C^1 : C^2 :: x : L - x$ and $x = \dfrac{C^1 L}{C^1 + C^2}$ ohms or metres, according as L is in terms of ohms or metres.

The above test, in its electrical development, is an adaptation of May's formula for localising an *earth* fault by the polarisation current emanating from the fault itself.

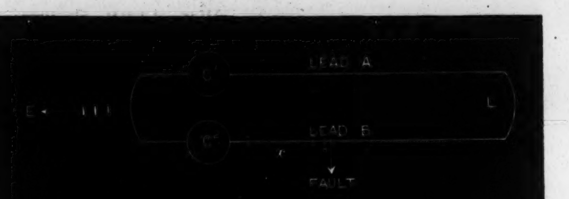
---

* This had reference to a Lacombe cell.

May's test is as in fig. 2, which shows line (L) with fault at F, and earthed at both ends through similar galvanometers,* the respective deflections of which may be termed C^1 and C^2. The polarisation currents from F, which flow through the two available branches, are, of course, inversely proportional to the resistances of those branches, so we have $C^1 : C^2 :: x : L - x$, and

$$x = \frac{C^1 L}{C^1 + C^2}, \text{ as above.}$$

FIG. 1.



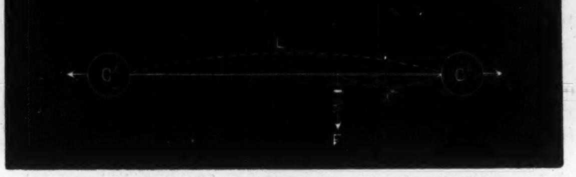
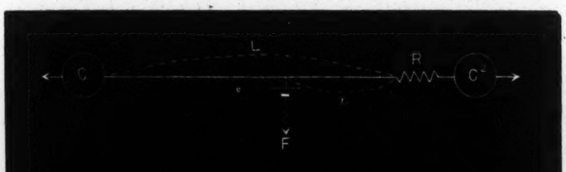


FIG. 2.

The following modification of this test, by the writer, is also applicable to M. Wilbrant's method with accumulators and ammeters.

If—in May's test—F be electrically midway between the two galvanometers, C^1 will equal C^2; but if not, then, of course, the galvanometer nearest the fault will give the higher deflection. Then, if the operator whose galvanometer gives the higher deflection, introduce a resistance R, sufficient to bring F electrically midway between the two galvanometers. sufficient—in other words—to make $C^1 = C^2$ (see fig. 3),

FIG. 3.



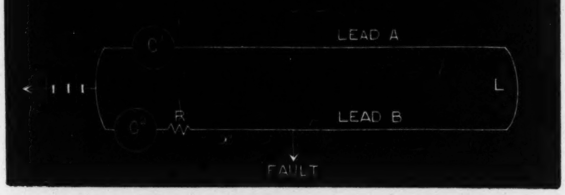


FIG. 4.

we shall have $C^1 : C^2 :: x + R : L - x$;

or, $$C^1 (L - x) = C^2 (R + x)$$

and $$x = \frac{C^1 L - C^2 R}{C^1 + C^2}$$

but $$C^1 = C^2, \text{ so } x = \frac{L - R}{2}.$$

applying the same modification to M. Wilbrant's test, we have (see fig 4):—

$$C^1 : C^2 :: x + R : L - x, \; x = \frac{C^1 L - C^2 R}{C^1 + C^2}$$

and if $$C^1 = C^2, \; x = \frac{L - R}{2}.$$

Perhaps this will be found the neater method of the two, especially if the coils at R (*) be arranged in resistance units equivalent to metres of line. Then, if L = total length in metres,

$$\text{Distance of fault} = \frac{L - R}{2} \text{ metres.}$$

Edward Raymond Barker.

B. S. T. Co., Madeira, *Nov.*, 1890.

The Life of Glow Lamps.

In your Correspondence columns of last week I notice a letter from Mr. Lott on "The Life of Glow Lamps on the Series System."

Before being able to attach any practical value to Mr. Lott's statement, might I ask him to kindly furnish the absolutely necessary figures or approximations as to the watts per C.P. that this lamp required initially and after burning 10,000 hours?

As I have often remarked before, in your columns, such statements of hours burnt, &c., are quite valueless unless C.P. and watt readings are simultaneously given. I believe it quite practicable for either a series or multiple glow lamp to burn considerably over 10,000 hours if always kept at a low enough efficiency, say 5 watts per C.P. and below.

If the particular lamp mentioned by Mr. Lott began at, say, 3 watts per C.P. and after 10,000 hours even went up to 4 watts per C.P., then I should consider that this denoted an excellent result and for practical reasons only would diminish the weight of Mr. Mordey's remarks, although his remarks must remain true in a theoretical sense.

C. J. Robertson,

Middleburg, Holland, *November* 12*th*, 1890.

The letter of Mr. Lott, in your issue of the 14th inst., is of interest. But at what efficiency was the particular lamp run? It may have rather a thick carbon which would account for the long life. But the "average life," is more important, with which perhaps your correspondent would favour us, and at the same time any information with regard to the reliability of the cut-out in the lamp would no doubt be of interest to your readers as well as myself.

J. E. Pearce.

November 17*th*, 1890.

Telopy or Telephany.

It may appear as though we were looking ahead too much when we discuss the name of that which is at present non-existent. But, as we are told that we should first work out our ideal, and afterwards approach that ideal as nearly as hard circumstances will permit, we may as well act on the same plan in this matter of naming an undiscovered instrument. Now, as words are only symbols to express our thoughts to others by writing or speaking, it is necessary that words, when written or spoken, should express those thoughts as clearly, as shortly, and as euphoniously as possible. The series of words Telopy, a Telopist, the Telope, I Teleope, seem to fulfil the required conditions better than Telephany, a Telephanist, the Telephane, I Telephane. If that which is expressed by these words becomes as common as telegraphy, we shall probably have some totally different word used; just as we have —a wire, and I wire. Meantime, for writing and lecturing purposes, which of the above groups of words shall we employ to express seeing at a distance?

A. C.

November 18*th*, 1890.

---

* If dissimilar galvanometers be used, knowledge of their respective *figures of merit* would still permit of comparison of deflections.

* These would be similar in general construction to those used in electric lighting, and in such like heavy work.

WOODHOUSE & RAWSON
WIRING TABLES.

These Tables have been constructod to assist Electrical Engineers in the selection of cables for the various currents which they are required to carry, and the form of the Tables is so designed that the correct cables may at once be selected, taking into consideration both the current-density and the fall of E.M.F.

PRICE.—Paper, 1s. 0d., post free 1s. 2d.; Mounted and Glazed, 1s. 6d., post free 1s. 9d.
Bound in neat Cloth, for Pocket, 2s. 6d., post free 2s. 9d.

Printed Directions how to use the Tables are issued with exch copy.

"THE ELECTRIC RAILWAY."
AND
"MUNICIPAL LIGHTING."
BY FRED H. WHIPPLE.

New and original Books, designed to inform a practical public without the use of difficult technical terms.
Bound in Paper, 4s. 6d.; bound in flexible Russia, 8s. 6d.

WOODHOUSE & RAWSON UNITED, LTD.,
88, QUEEN VICTORIA STREET, LONDON E.C.
41, PICCADILLY, BRADFORD, YORKS.
CORNBROOK TELEGRAPH WORKS, MANCHESTER.
STRAND WORKS, CHISWICK, W.
UNION FOUNDRY, KIDSGROVE.

Daily Calendar for 1890, or Celluloid Paper Knife and Calendar, Post Free, 3d. each.
803

REID BROTHERS,
12. WHARF ROAD. CITY ROAD. LONDON. N.
TELEGRAPH ENGINEERS AND CONTRACTORS
For the Supplying, Erecting, and Laying Down Under-Ground Wires both for
TELEGRAPHS AND ELECTRIC LIGHTING
PNEUMATIC TUBES FITTED WITH ENGINES AND PUMPS COMPLETE.
MAKERS OF RADCLIFFE'S PATENT ELECTRICAL SIGNAL LOCKING APPARATUS.
PATENT TELEPHONIC WIRES
TO PREVENT INDUCTION BOTH FOR UNDER-GROUND AND OVER-HEAD LINES.
MANUFACTURERS OF SUBMARINE CABLES. WIRE. IRON POLES. INSTRUMENTS. BATTERIES. INSULATORS AND STORES OF EVERY DESCRIPTION.
Contracts entered into for the Supply, Construction, and Maintenance of Telegraph Lines.
209

CALLENDER'S BITUMEN TELEGRAPH & WATERPROOF Co.,
LIMITED.
101, Leadenhall Street, LONDON. Telegrams: "CALLENDER, LONDON." Telephone, No. 4,485.
LIVERPOOL: 36, Dale Street.
Works: ERITH, KENT. Telegrams: "CALLENDER, PICARDY." Telephone, 8,411.

UNDERGROUND MAINS
LAID COMPLETE ON CALLENDER-WEBBER OR SOLID BITUMEN SYSTEMS.
LEAD SHEATHED WIRES AND CABLES
FOR UNDERGROUND WORK, HOUSE AND FACTORY MAINS AND SHIP WORK.
Concentric Cables—ARMOURED—Metal Sheathed.
AERIAL CABLES.
1386

VERITY'S PATENT "QUICK MAKE & QUICK BREAK" SWITCHES

Are the best in the market. A Large Stock always in hand with China or Brass Covers, or Special Cast and Chased Work suitable for High-Class Decoration.

VERITY'S PATENT "SAFETY" SAFETY CUT-OUTS.

Best and cheapest in the Market. By their use it is impossible to place a large fuse in a block intended for a smaller size. This result is not obtainable with any other Cut-out.

VERITY'S ELECTRIC LIGHT FITTINGS.

The largest Stock and most varied assortment in London.

VERITY'S,

KING STREET, COVENT GARDEN, W.C.; and 137, REGENT STREET, W.

TELEPHONE 2648. Telegrams: "ELECTROLER, LONDON." 3510

FOR ENGINEERS' LATHES,

DRIVEN BY SELF-CONTAINED ELECTRIC MOTORS, 3671

Apply to **R. BOLTON & CO., 110, Leadenhall St., E.C.**

THE BERNSTEIN ELECTRIC LAMP CO.,

(LIMITED),

2, MARLBOROUGH MANSIONS, VICTORIA ST., LONDON, S.W.

OWNERS of the BERNSTEIN SYSTEM of ELECTRIC LIGHTING.

☞ **The lamps of this Company are of low resistance, and entirely free from the claims of other companies.** 112

ENGINEERS' CASTINGS

BRASS, GUN METAL,

PHOSPHOR BRONZE

CASTINGS

AND

INGOTS,

PHOSPHOR TIN,

"ALBION" BRAND,

BABBITT'S METAL,

&c., &c

ESTABLISHED 1830.

J. & J. HUGHES,

ALBION METAL WORKS,

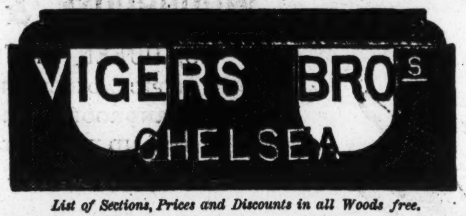
WOODCOCK STREET,

BIRMINGHAM.

Telegrams "Bronze," Birmingham. 3886

ELECTRIC WIRE CASINGS.

Telephone No. 3188.



List of Sections, Prices and Discounts in all Woods free.

Mahogany and Timber Importers, Importers of School Board Flooring Blocks, Figured Wainscot Floorings, and Manufacturers of High-Class Mouldings in all woods.

Head Office: 214, PAVILION ROAD, SLOANE SQUARE, S.W.

Saw Mills: Stanley Bridge Wharf, King's Road, CHELSEA.

Branch Yard: 65a, Poland Street, Oxford Street, W. 2871

GENT & CO.,

FARADAY WORKS, LEICESTER,

ELECTRIC LIGHT ENGINEERS,

Manufacturers, Wholesale and for Export, of

EVERY DESCRIPTION OF ELECTRICAL APPARATUS

WHOLESALE AGENTS FOR

GASSNER'S DRY CELL.

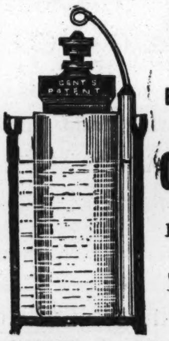
ALSO MAKERS OF

MEDICAL BATTERIES

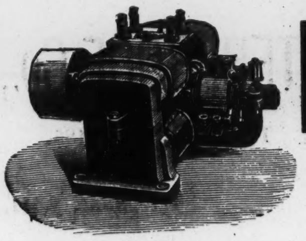
With special form of Dry Cell.

WATCHMAN'S CLOCKS.

TELEPHONES.



GENT & CO.'S PATENT INSULATED CELL 2111



ROPER'S PATENT DYNAMOS

Used for the last six years with the greatest success.

GOLD MEDALS AWARDED.

Cheap, Efficient, Strong, Silent. No Sparking! No Overheating!

ILLUSTRATED CATALOGUES AND PRICES ON APPLICATION.

JOHN & Wm. ROPER, BRADFORD, Yorks. 3315

GÜLCHER ELECTRIC LIGHT & POWER COMPANY, LTD.

ARE NOW MANUFACTURING SPECIALLY FOR THE TRADE.

BATTERSEA DYNAMOS.	
300 Lights,	£175
400 "	£220
500 "	£265
650 "	£320

TRANSFORMERS
ARC LAMPS

ELECTRICAL
APPARATUS

"BATTERSEA" DYNAMO

AND

BATTERSEA
MOTOR

THE GULCHER ELECTRIC LIGHT & POWER Co
BATTERSEA FOUNDRY S.W.

BATTERSEA MOTORS.	
26 H.P.	£175
33 H.P.	£220
40 H.P.	£265
55 H.P.	£320

3121

For Catalogue and Particulars apply to THE MANAGER, BATTERSEA FOUNDRY, S.W.

JOSEPH BOURNE & SON,

MANUFACTURERS OF THE WELL-KNOWN

STONEWARE TELEGRAPHIC INSULATORS AND BATTERY JARS.

For Thirty years these manufactures have been celebrated for a high degree of vitrefaction combined with great toughness and strength.

Brown Stoneware. White Stoneware. Brown Porcelain. Porous Cells.

Economy Strength and Durability combined. *Prize Medal, Paris Electrical Exhibition.*

Special Shapes for Telephone and Electric Lighting Wires.

Works: DENBY POTTERY, NEAR DERBY.

London Office: NEW ST. PANCRAS STATION EUSTON ROAD, N.W. 3687

TRADE MARK ROBIN HOOD R.C.&Co B.

RAMSDEN, CAMM & CO.,

BRIGHOUSE, YORKSHIRE,

Iron and Steel Wire Drawers and Galvanizers.

MANUFACTURERS OF

TELEGRAPH, TELEPHONE AND CABLE WIRE,

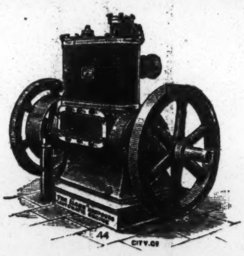
Contractors to H.M. Postmaster-General, the Indian and Colonial Governments and leading Railway Companies

SPECIALITIES:—FINE SIZES OF H.C. COPPER, GERMAN SILVER, &c., WIRES. 3989

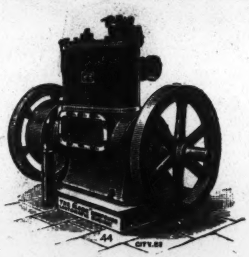
THE GLOBE

COMPOUND ENGINE.

Simple, Economical, Durable.



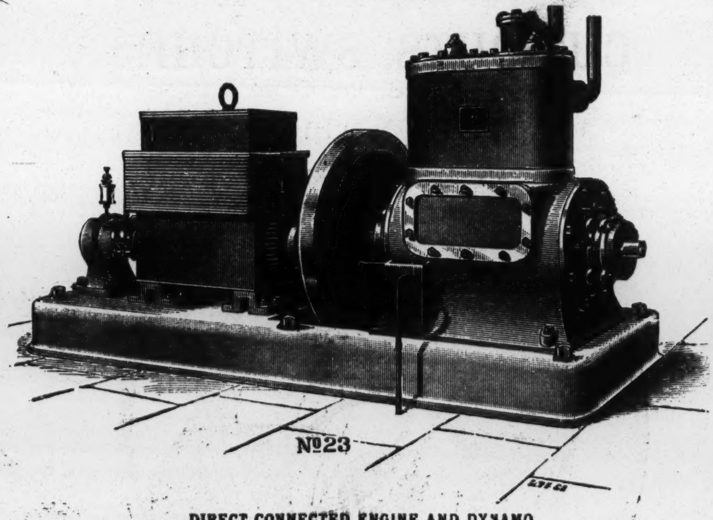
STANDARD ENGINE.



STANDARD ENGINE.

USED FOR ALL PURPOSES.

LARGE STOCK ON HAND.



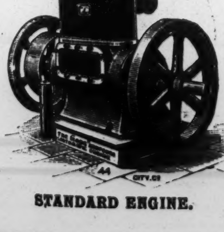
No 23

DIRECT CONNECTED ENGINE AND DYNAMO.

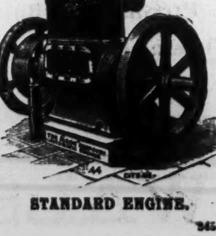
All Sizes Furnished, 10 to 350 H.P.

BOILERS, FEEDWATER HEATERS, &c.

Write for Circulars.



STANDARD ENGINE.



STANDARD ENGINE.

JOHN MUSGRAVE & SONS,

LIMITED,

GLOBE IRON WORKS, BOLTON.

London Agents:

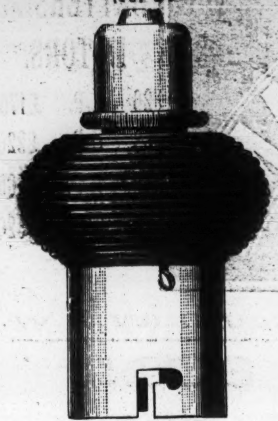
S. & E. RANSOME & CO., 10, Essex St., Strand, W.C.

3454

WALSALL ELECTRICAL CO., WALSALL.

"BOSS" HOLDER.

No. 3.

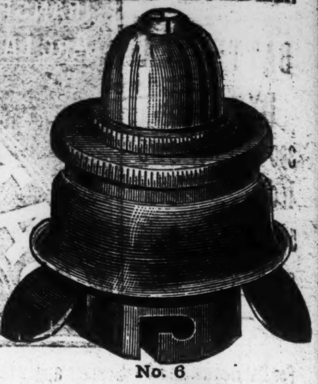


Rd. 121735

GUARANTEED CORRECT.
Divided into Tenths.

PRICE 42s.
Graduated to 3 or 4 Volts.

WALSALL HOLDER.



No. 6

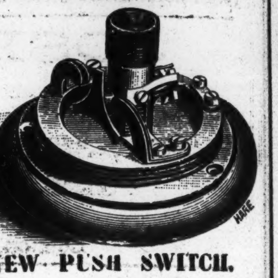
THE

SPECIAL VOLTMETER.

Specially suited for Testing the Conditions of Accumulators.

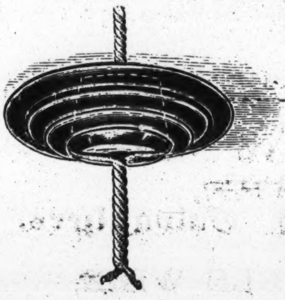
IMPROVED,
LARGER SCALE,
NEARLY DEAD BEAT.

SOLID LEATHER CASES, WITH SLING STRAP, 10s. EXTRA.



NEW PUSH SWITCH.

Press Once to Light the Lamp, which is Extinguished by a Second Push.



LAMPHOLDERS

UNDER LICENSE
FROM THE EDISON-SWAN CO.

New Patent
CEILING ROSE.

AMMETER,

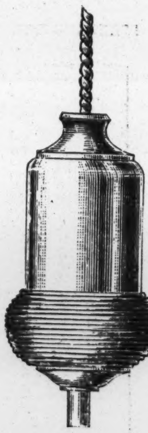
4 AMPS. IN TENTHS,

42s.

CUT-OUTS, SWITCHES,

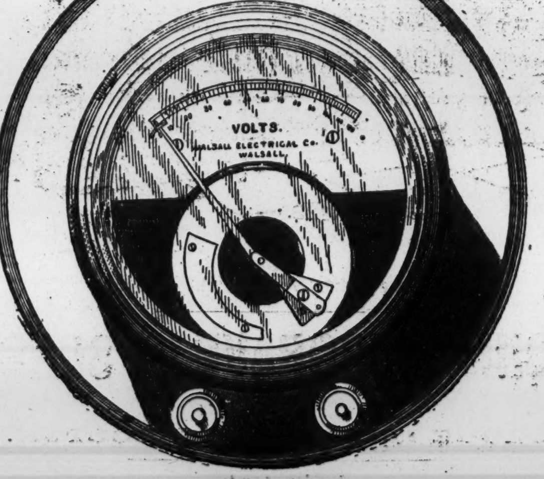
&c., &c.

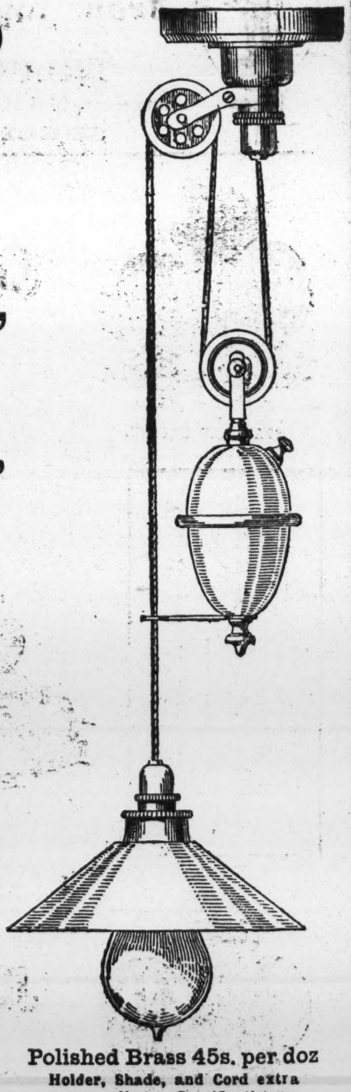
NEW LIST ON APPLICATION.



PRESSEL SWITCH,
5s.

Pressing the Button alternately Lights and Extinguishes a Lamp, or group.





Polished Brass 45s. per doz
Holder, Shade, and Cord extra according to Specification.

2957

WALSALL ELECTRICAL CO.

G. P. WALL,

MAGNETO WORKS, SHEFFIELD.

◆◆◆◆◆◆

SPECIALITIES of STEEL and STEEL WIRE adapted to the INSTRUMENT and ELECTRICAL TRADES.

MAGNET STEEL of the highest efficiency.

SWEDISH IRON, ABSOLUTELY PURE AND DIAMAGNETIC.

TOOL STEELS—ALL DESCRIPTIONS.

COLD ROLLED STEEL in all dimensions. COLD ROLLED STEEL tempered and polished in strips.

SPRINGS, HELICAL, SPIRAL, OR TO PATTERNS.

Best Round Steel Wire Polished in Lengths or Coils, all gauges. Tempered Wire, Polished and Plated Music Wire, Qualities for Springs, &c.

[illegible]

KING, MENDHAM & CO.,

WESTERN ELECTRICAL WORKS, BRISTOL,

Manufacturers of

WIMSHURST INFLUENCE ELECTRICAL MACHINES

Of New and Improved Pattern, with and without Glass Case, double or quadruple plates. Acknowledged to be the best finished and most efficient machines in the market.

Electric Bells and Indicators, Automatic Gas Lighting Burners, K. M. B. Patent Pocket Galvanometers Deprez-D'Arsonval and other Galvanometers, Resistance Coils, Metre and Wheatstone, Bridges, Morse Sounders of special pattern, Lightning Conductors supplied and erected, and thorough efficiency guaranteed.

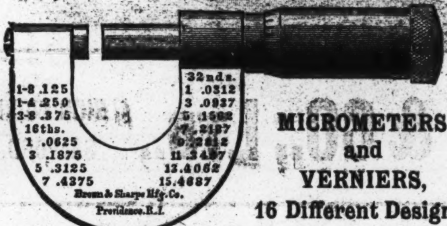
NEW PRICE LIST, POST FREE, 1½d. *Telegraphic Address: "KINGHAM BRISTOL."* 5061

Specially Compiled List of Electrical Publications, Post Free 2d.

IMPORTERS OF FINE AND ACCURATE

AMERICAN MACHINERY & TOOLS

QUICK SPEED SENSITIVE DRILLING MACHINES WITH ONE OR MORE SPINDLES. ALSO HEAVY POWER DRILLS.



MICROMETERS and VERNIERS, 16 Different Designs.

MILLING MACHINES, LATHES, &c.

FINE TOOLS IN GREAT VARIETY.

SEND **1s.** FOR ILLUSTRATED CATALOGUE.

CHARLES CHURCHILL & CO., Ltd.,

21, CROSS STREET, FINSBURY, LONDON. [illegible]

THE NEWTON ELECTRICAL ENGINEERING WORKS, TAUNTON.

THE

"TAUNTON" DYNAMOS

AND

MOTORS.

Highest Efficiency; Beauty of Design; Moderate Speeds; Best Workmanship and Materials.

NEWTON & HAWKINS'

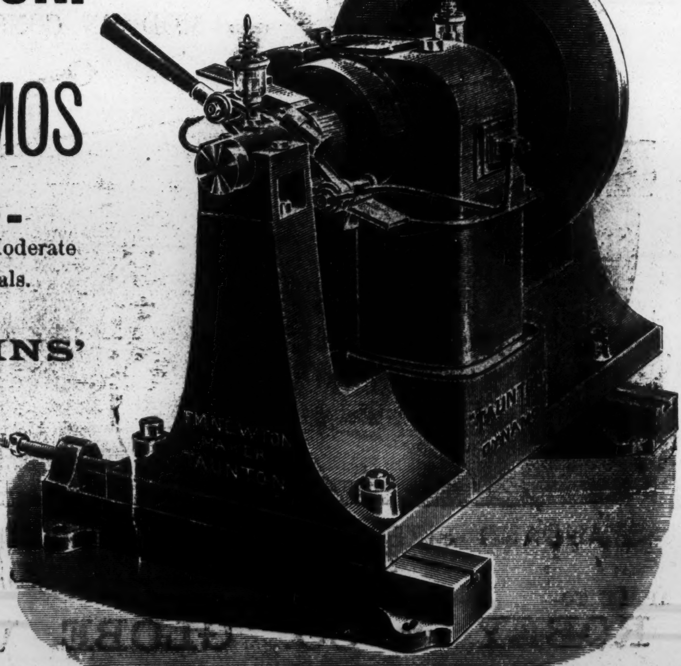
PATENT

AUTOMATIC SWITCHES.

NEWTON **ARC** LAMPS.

And every Requisite for Electric Lighting and Transmission of Power. 3903

Telegrams: "ARC," TAUNTON.



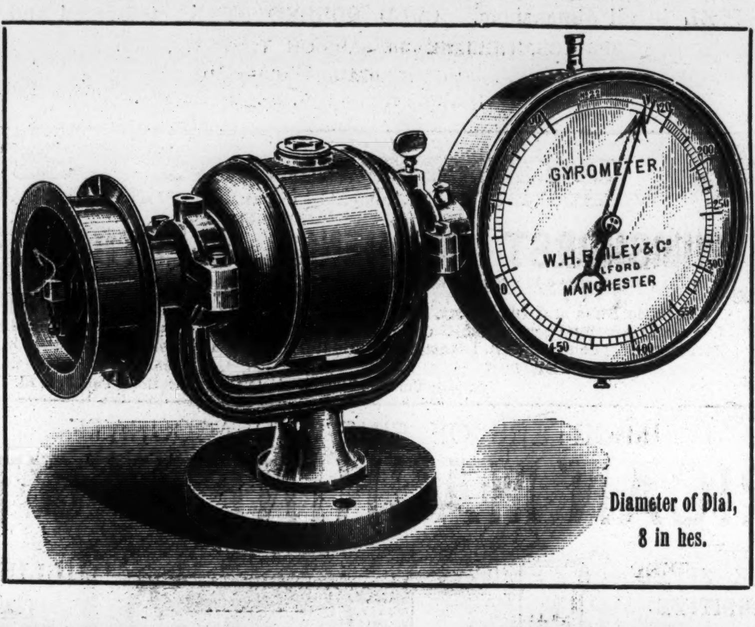
BAILEY'S

"GYROMETER" OR SPEED INDICATOR

FOR USE WITH

Electrical Installations and with General Machinery.

AS MANUFACTURED BY US FOR THE BRITISH ADMIRALTY FOR WAR VESSELS.



Diameter of Dial, 8 inches.

AND ALSO FOR MOST OF THE CHIEF ELECTRICAL ENGINEERS HERE AND ABROAD.

SOLE MAKERS,

W. H. BAILEY & CO., LTD., ALBION WORKS, SALFORD, MANCHESTER.

3070

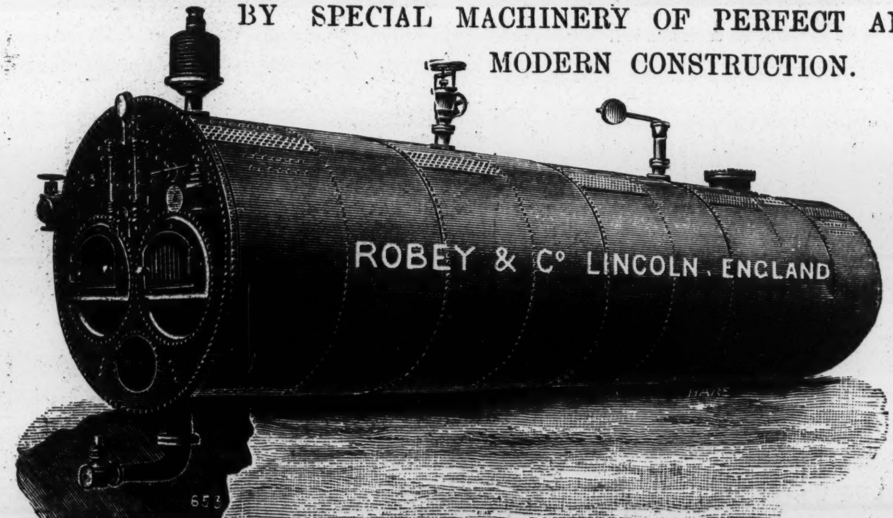
ROBEY & CO.,

GLOBE WORKS, LINCOLN,

MANUFACTURERS OF

CORNISH AND LANCASHIRE BOILERS

BY SPECIAL MACHINERY OF PERFECT AND MOST MODERN CONSTRUCTION.



Rivetted by Hydraulic Machinery.

All Holes drilled in position.

Constructed in sizes of from 4 to 40 H.P. and from 80 lbs. to 140 lbs. working pressure.

STANDARD SIZES IN STOCK OR PROGRESS FOR QUICK DELIVERY.

Estimates given on receipt of specification of requirements.

APPLY TO—

ROBEY & CO., GLOBE WORKS, LINCOLN.

4080

J. G. STATTER & CO., LTD.,

ALLIANCE ENGINEERING WORKS WEST DRAYTON NEAR LONDON.

London Office: PRINCE'S MANSIONS, 68, VICTORIA ST., WESTMINSTER.

"ALLIANCE" DYNAMOS AND MOTORS for all purposes. All sizes ready for immediate delivery. Made by special machinery in the best manner possible and of the very best materials.

THE STATTER PATENT CONSTANT CURRENT DYNAMO has a higher commercial efficiency than any other, either English or American.

SPECIAL AUTOMATIC ENGINES and DYNAMOS for SHIP LIGHTING

Everything Electrical. Write for Lists. *Note to Contractors.*—Messrs. Statter do not tender for wiring jobs. *Telegrams:* "*Statter West Drayton.*" 1981

VULCANITE.

Sheets, Rods, Tubes, Cells, &c., for Electrical Purposes.

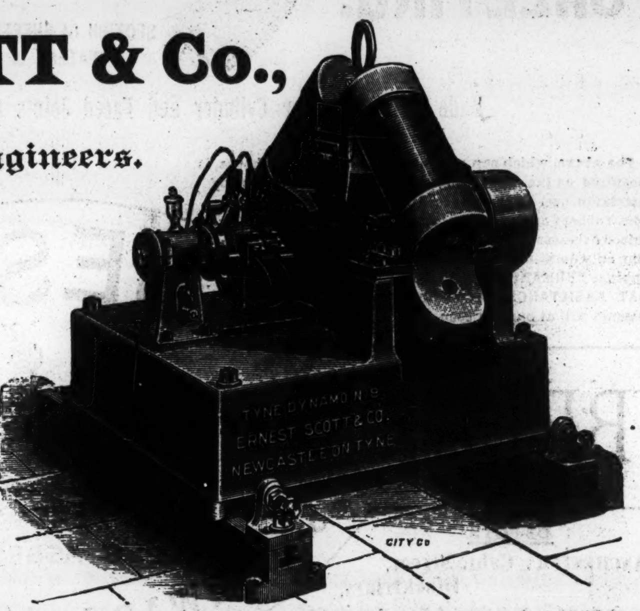
THE NORTH BRITISH RUBBER CO., LIMITED,

Edinburgh; London, 57, Moorgate St.; *Manchester,* 6, Charlotte St.
Liverpool, 9, Lord Street; *Glasgow,* 106, Buchanan St.;
Newcastle-on-Tyne, 39, Grainger St.; *Leeds,* 65 & 66, Briggate. 3747

ERNEST SCOTT & Co.,

NEWCASTLE-ON-TYNE,

Electrical and General Engineers.



TYNE DYNAMOS,

TYNE ARC LAMPS,

TYNE TRANSFORMERS.

Complete Installations erected by experienced men at home and abroad.

SPECIAL TERMS TO THE TRADE.

Complete Catalogue on application.

Offices:	*Telegraphic Addresses:*
LONDON: 110, Leadenhall Street.	"Boltonite," London.
MANCHESTER: 24, Victoria Buildings.	"Ampère," Manchester.
HUDDERSFIELD: Lancaster Yard, Cloth Hall St.	"Dynamo," Huddersfield.
GLASGOW: 53, Waterloo Street.	"Roots," Glasgow.
NEWCASTLE-ON-TYNE: Close Works.	"Esco," Newcastle-on-Tyne.
JOHANNESBURG SOUTH AFRICA.	"Mulhause," Johannesburg.

3311

MARSHALL, SONS & Co., Ltd.,

Highest Award MELBOURNE INTERNATIONAL EXHIBITION, 1889.—First Prize and Special Mention for Excellence for Engines First Prize and Special Mention for Excellence for Thrashing Machinery.

BRITANNIA IRON WORKS, GAINSBOROUGH.

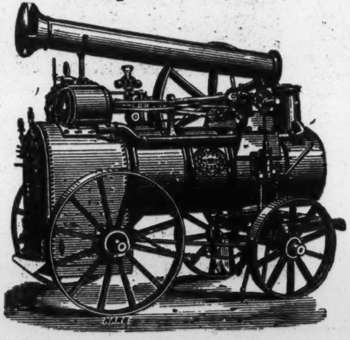
London Offices, Show Rooms & Stores:—MARSHALL'S BUILDINGS, 79, FARRINGDON Rd., E.C.

Telephone No. 6,648.

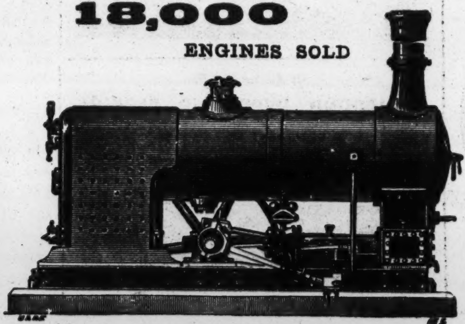
MORE THAN

18,000

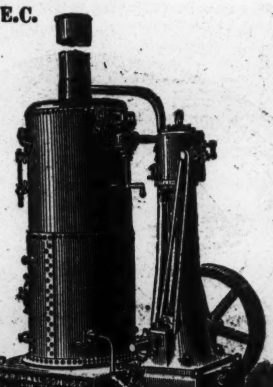
ENGINES SOLD



Portable and Semi-Portable Engines, with Automatic Expansion Gear.



Underneath Engines, Simple and Compound, for Extreme Economy in Fuel.



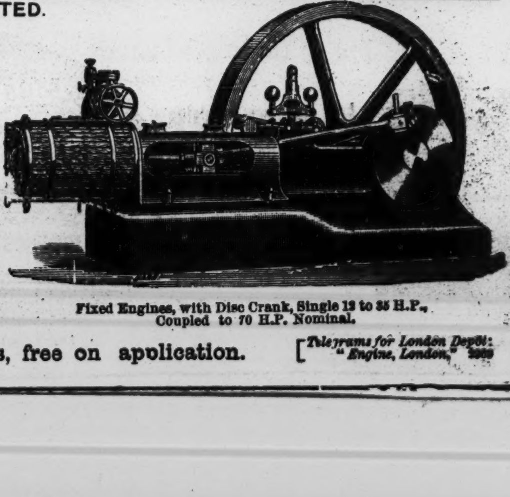
Vertical Engines and Boilers.

☛ M. S. & CO. KEEP A LARGE STOCK OF ENGINES &c. OF ALL SIZES AT THEIR LONDON DEPOT FOR IMMEDIATE DELIVERY ON SALE OR HIRE.

INSPECTION INVITED.

Fixed Engines, 3 to 10 H.P., with Inside Crank, for Cornish or Loco-Multitubular Boilers.

Vertical Engines for Ship Lighting and Small Installations.



Fixed Engines, with Disc Crank, Single 12 to 35 H.P., Coupled to 70 H.P. Nominal.

Gold Medal, Highest Award, Liverpool Exhibition, 1886; Gold Medal, Highest Award, Edinburgh Exhibition, 1886.

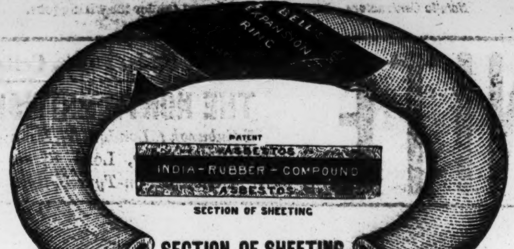
Telegrams for Works: "*Marshalls, Gainsboro'.*"]

New Catalogues, with Current Prices, free on application.

[*Telegrams for London Depôt:* "*Engine, London,*" [illegible]

BELL'S ASBESTOS

EXPANSION SHEETING.



SECTION OF SHEETING. PATENT

EXPANSION RINGS.

Made from 1-Ply for Cylinder and Faced Joints to any thickness for uneven surfaces.

The above, which can only be obtained from this house, is recognised as the Most Efficient and Economical Jointing Material in use. It is composed of a specially-prepared India-rubber Compound, protected by a covering of Vulcanised Asbestos Sheeting, as shown above, and as it is the only Jointing Material which adequately combines PERMANENT ELASTICITY WITH HEAT RESISTANCE, the advantages it possesses will at once be seen.

The Centre from which the requisite elasticity is obtained will adapt itself to uneven surfaces to which it may be applied, and allow the expansion and contraction to be fully taken up. The covering being of Asbestos Cloth, imparts a protection to the centre and so prolongs its elasticity. For Manhole, Mudhole, Steam Pipe, and Mash Tun Door Joints it is unequalled, and if applied as directed a ring can be used many times over.

BELL'S ASBESTOS CO., LTD.

TRADE MARK.

BELL'S ASBESTOS.

SOUTHWARK, LONDON, S.E.

DEPOTS

MANCHESTER: Cable Street, Blackfriars.
LIVERPOOL: 2, Strand St., James St.
BELFAST, DUBLIN, ANTWERP, BERLIN,

DEPOTS:

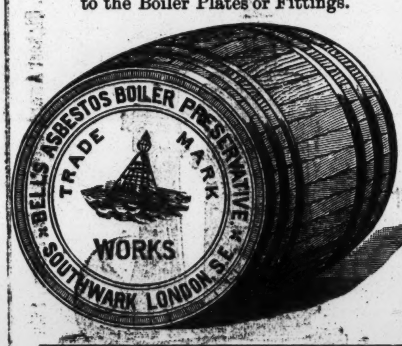
HULL: Humber Dock Basin.
GLASGOW: 35, Robertson Street.
BARCELONA, TRIESTE, LISBON & GENOA.

AGENTS.—BIRMINGHAM—BELL & Co., 7, John Bright Street. CARDIFF: BELL & Co., West Bute Street.

BELL'S ASBESTOS

BOILER PRESERVATIVE

Will effectually keep Boilers clean and remove any Incrustation, without injury to the Boiler Plates or Fittings.



BELL'S ASBESTOS

YARN & SOAPSTONE PACKING

Is the BEST LOCOMOTIVE PACKING made.

BELL'S

COMPOUND HYDRAULIC PACKING

IS SPECIALLY SUITED FOR HYDRAULIC MACHINERY, ACCUMULATORS, AND AMMONIA AND ALL PUMPS.

BELL'S ASBESTOS.

NON-CONDUCTING COMPOSITION.

Will reduce loss by radiation, and saves 40 per cent. of fuel.

Is sent out dry in bags therefore cheaper than others sent out wet.

AWARDED GOLD MEDAL INVENTIONS EXHIBITION 1885
BELL'S ASBESTOS
TRADE
NON-CONDUCTING COMPOSITION

All bags are marked as above.

BELL'S ASBESTOS LUBRICANT.

Any customer receiving Oil sold as Bell's Asbestos Lubricant, & Cask, Drum, or Corks not marked as

shown, is earnestly requested to forward us sample and particulars of where obtained.

ASBESTOS BELL'S LUBRICANT

Drums are marked as above. Every Cask is sent out as above. All Corks are sealed as above.

BELL'S ASBESTOLINE.

REGISTERED.

All kegs are labelled as above.

ADVANTAGES OF ASBESTOLINE.

ASBESTOLINE is the most efficient Lubricant for all bearings.
ASBESTOLINE is the cheapest Lubricant.
ASBESTOLINE saves from 50 to 90 per cent. of the Cost of Oil.
ASBESTOLINE is the Cleanest Lubricant.
ASBESTOLINE is favoured by Insurance Companies.
ASBESTOLINE is the most Inodorous Lubricant.
ASBESTOLINE is the safest Lubricant, its flashing point being 700 F.
ASBESTOLINE has beaten all other Lubricants in making trials.
ASBESTOLINE is applicable in and out doors in every climate.
ASBESTOLINE requires no special application.

BELL'S ASBESTOS.

CONSISTENCY OF ASBESTOLINE.

ASBESTOLINE, to meet all circumstances, is made in four degrees of consistency, A, B, C, and CC.

ASBESTOLINE A. is specially adapted to ordinary Land Engines and Machinery, in and out-door, in this country.

ASBESTOLINE B, a little more solid, is for use on Steamships in temperate climates, also on land when it is desirable to have Lubricant stiffer than A.

ASBESTOLINE C. is for use in tropical climates, both ashore and afloat. It is also invaluable in works in this country when the temperature is high.

ASBESTOLINE CC, is designed for use on calenders, paper machines, &c., where the bearings are heated by steam passing through, and sometimes is advantageously used instead of C.

The reputation of Asbestoline as a lubricant of the highest efficiency in every kind of machinery is established, and it has never been equalled by any other lubricant in the numerous cases of special difficulty in which the best oils are ineffectual. This reputation is growing daily, because it is **based on the experience of thousands of users** under the severest circumstances any lubricant has ever been subjected to, **and not on mere laboratory tests** and professional analysis of insignificant quantities. It is used with marked success in Steel and Iron Works, Collieries, Cotton and Wool Mills, and other Textile Manufactories. In Corn Mills it has proved invaluable on the roller and other modern machines. In Saw Mills, on Machines going up to 5,000 revolutions per minute, its work has never been approached by any other lubricant. On Electric Lighting Machinery, and in Steamships of all sizes throughout the world, the success of Asbestoline is unequalled. Many engines and machines of all descriptions give trouble and show bad results, both in working and wear, when the system of lubrication has not received due consideration. Engineering firms of the highest standing have given to it their powerful testimony and support.

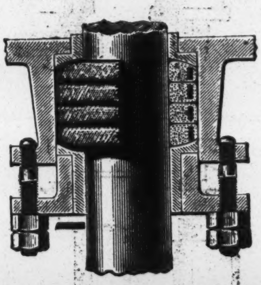
SUPPLIED IN KEGS, 28 lbs., 56 lbs., or 112 lbs.

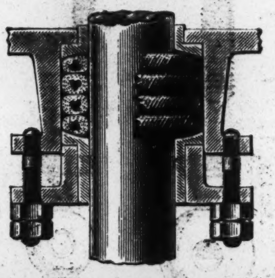
SPECIAL TERMS FOR LARGE QUANTITIES.

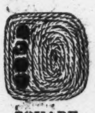
IMPORTANT TO EXPORT MERCHANTS.—One Pound of "Asbestoline" equals 2 gallons of Oil weighing 18 lbs. consequently the saving in freight is very considerable. Liberal Terms are conceded to Export Merchants.

BELL'S ASBESTOS DAGGER PACKING

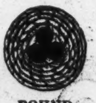
Patent.







SQUARE.



ROUND.

Every 10 feet has label as above, and bears our Trade Mark.

Under this registered title are included the inventions of Mr. Field, and experience has proved them to be **THE MOST EFFICIENT, DURABLE, AND ECONOMICAL PACKINGS** ever made. They constitute such a combination of Asbestos and India-rubber as secures the maximum of elasticity and heat resistance, and they are therefore **UNEQUALLED FOR EVERY KIND OF ENGINE.** These Packings are being universally used by most of the leading Steamship Companies throughout the world for ordinary Compound, Triple, and Quadruple Expansion Engines of the latest type. These Packings are composed of Rolled Asbestos Cloth, but the India-rubber is placed in two forms to suit various cases.

☞ **In ordering, state whether square or round required.** ☜

BELL'S ASBESTOS COMPANY, LIMITED,

SOUTHWARK, LONDON, S.E.

DEPOTS:—MANCHESTER: Cable Street, Blackfriars. LIVERPOOL: 2, Strand St., James St. HULL: Humber Dock Basin. GLASGOW: 35, Robertson St. DUBLIN, BELFAST, ANTWERP, BERLIN, BARCELONA, TRIESTE, LISBON, & GENOA.

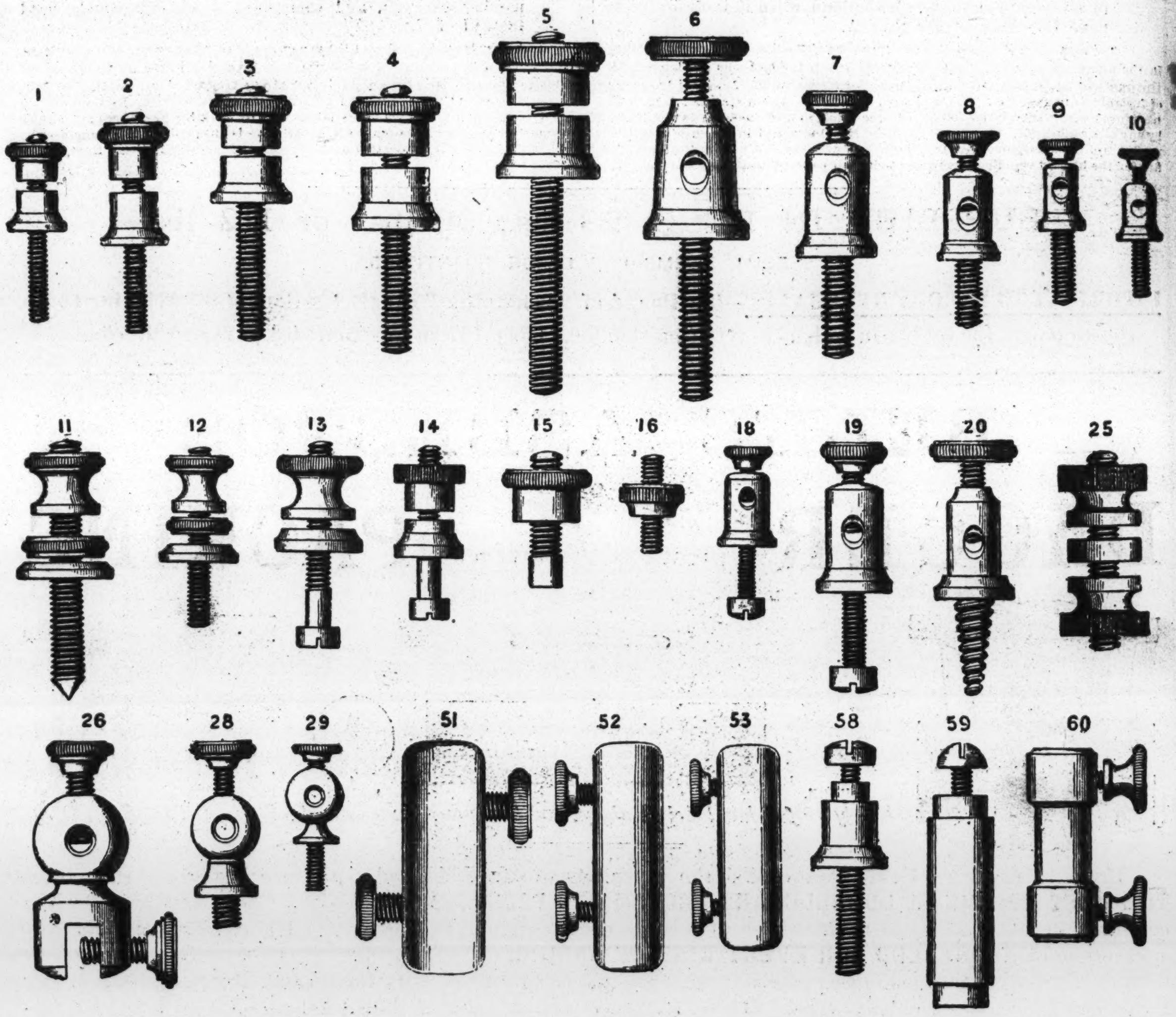
AGENTS:—BIRMINGHAM: BELL & CO., 7, John Bright Street. BRISTOL: ROBERT STOTESBURY, 114, Redcliff Street. CARDIFF: BELL & CO., West Bute Street.

8 2223

DAVIS & TIMMINS,
LIMITED,
Screw Manufacturers,
24. CHARLES ST., HATTON GARDEN,
LONDON, E.C.

TWO MEDALS
AWARDED
For Excellency of Manufactures,
PARIS INTERNATIONAL EXHIBITION, 1889.

ALL THESE GOODS ARE SHOWN FULL SIZE AND KEPT IN STOCK



SOLE AGENTS FOR J. O. MOUCHEL'S HIGH CONDUCTIVITY COPPER WIRE.

STRAIGHT DRAWN, BRASS, IRON AND STEEL, ROUND HEXAGON AND FLAT,
ALL SIZES KEPT IN STOCK.

ESTIMATES FOR SCREWS AND TURNED PARTS ON RECEIPT OF PATTERNS.

Considerable Reduction for Large Quantities. 3091

TELEPHONE NUMBER 1140.

PATERSON & COOPER

Telegraph Address: "PATELLA," LONDON.

Gordon Voltmeter, [illegible]

Phoenix Ammeter, [illegible]

Beg to give notice that for the convenience of customers to whom the West End of London is easier of access than Dalston they have now opened BRANCH OFFICES and SHOW-ROOMS at

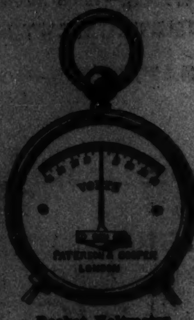
3, PRINCES MANSIONS,

VICTORIA STREET, WESTMINSTER,

Where Samples of their manufactures, and a good assortment of Fittings suited for Electric Light Installations, will be always on view.

DYNAMOS, VOLTMETERS,
ARC LAMPS, SWITCHES,
AMMETERS, CUT-OUTS,

And all Machinery and Requisites used for Electric Light or Power.



Pocket Voltmeter, [illegible]

PRICE LISTS POST FREE. SPECIAL TERMS TO LARGE BUYERS.

HEAD OFFICE AND WORKS:—
POWNALL ROAD, DALSTON, LONDON.
GLASGOW BRANCH:—
137, WEST REGENT STREET, GLASGOW.
WEST END BRANCH AND SHOWROOMS:
3, PRINCES MANSIONS, VICTORIA STREET, WESTMINSTER.

Telephone No. 5422. ESTABLISHED 1870. Telegrams: "Flexible, London."

SILVER MEDAL INTERNATIONAL ELECTRIC EXHIBITION, 1882.

PHILLIPS BROTHERS,

Electricians,

OFFICES AND WORKS: THE LEA TELEGRAPH WORKS, HACKNEY WICK, LONDON E.

MANUFACTURERS OF CABLES, WIRES, &c., TO ANY SPECIFICATION.

MULTIPLE CABLES, AERIAL AND SUBTERRANEAN.

Gutta-Percha, India-Rubber, and Compound Wires of every description for Telephone and Electric Bell Work.

FANCY BRAIDED WIRES OF EVERY DESCRIPTION.

COTTON AND SILK COVERED WIRES FOR DYNAMO MACHINES, MAGNETS, &c., &c. 2177

THE SCHOOL OF

ELECTRICAL ENGINEERING

AND SUBMARINE TELEGRAPHY.

ESTABLISHED IN 1868.

12 PRINCES STREET, HANOVER SQUARE, LONDON, W.

Manager:—Wm. LANT CARPENTER, B.A., B.Sc., F.C.S.
Secretary:—LEON DRUGMAN, A.S.T.E.
Senior Instructor:—CHAS. CAPITO, M.I.M.E., M.S.T.E. and E.

THIS Establishment is now the largest and the most fully equipped School of its kind. It possesses, among recent additions, several Dynamo Machines and Electric Motors, a 6-horse Boiler and Steam Engine, a Gas Engine, 46 E.P.S. Accumulator Cells, Lathes, &c., as well as several kinds of Arc and Incandescence Lamps and a Photometer Room. Both Theoretical and Practical Training can therefore be obtained. Since its opening in 1868 more than 3,450 Pupils have passed through the School. At the end of the course of instruction, an Examination for the CERTIFICATE OF THE SCHOOL is conducted by an Examiner of high standing, unconnected with the School. New Courses usually commence early in January, May, and September.

For full prospectus, terms, &c., apply to the Secretary, 12, Princes Street, Hanover Square, W. 841

INDIA-RUBBER, GUTTA-PERCHA, & TELEGRAPH WORKS COMPANY, LIMITED.

Offices and Warehouses: 106 & 100, CANNON STREET, LONDON, E.C.
Works: Silvertown, Essex; Persan-Beaumont, France.

TELEGRAPH ENGINEERS AND MANUFACTURERS

OF

CABLES.—Submarine, Subterranean, and Aerial.

WIRE.—India-Rubber and Gutta-Percha covered in all gauges.

INSTRUMENTS.—"Morse" Inkers, Single Needle, Wheatstone's Alphabetical, Semaphore "Block" Instruments, Bells, Resistance Coils, Sir W. Thomson's, and other Galvanometers, Condensers, Testing Instruments, &c.

BATTERIES.—SOLE MANUFACTURERS FOR GREAT BRITAIN, IRELAND, AND THE COLONIES OF THE CELEBRATED LECLANCHE BATTERY, which has received the most favourable reports from the Postal Telegraph Authorities and other eminent Telegraph Engineers, and is now in general use by the Post Office and English and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. All other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

INSULATORS.—Ebonite, Porcelain, Brownware, &c.

MANUFACTURERS OF THE MOST IMPROVED APPARATUS FOR RAILWAY BLOCK SIGNALLING.

SEMAPHORE REPEATERS, LIGHT" INDICATORS, AND WALKER'S "PASSENGER AND GUARD" COMMUNICATOR.

TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

TORPEDO APPARATUS.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY (Limited) are Patentees and Manufacturers of a Complete System of Torpedoes for Harbour and Coast Defence,

AND OF THE

SILVERTOWN PATENT FIRING BATTERY.

A Constant Battery for Mining and Blasting Purposes.

CONTRACTS ENTERED INTO for the SUPPLY, CONSTRUCTION, and MAINTENANCE of TELEGRAPH LINES.

MANUFACTURERS OF

VULCANISED INDIA RUBBER.

VALVES SHEET, BUFFERS, SPRINGS WASHERS WHEEL TYRES CORD TUBING, AND DOOR AND CARRIAGE MATS.

INDIA RUBBER AND CANVAS SUCTION AND DELIVERY HOSE.

INDIA RUBBER and CANVAS STEAM PACKING—ROUND, SQUARE, and SHEET.

INDIA RUBBER MACHINE DRIVING BANDS.

WATERPROOF GARMENTS AND FABRICS:

Coats, Capes, Leggings, Hats, Helmets, Knee Wrappers, Diving Dresses, Sheeting for Hospitals, Water and Air-Proof Beds, Pillows, Cushions, Bottles, Baths, Life Belts, Gas Bags.

EBONITE.

Not affected by Vinegar or Hydrochloric or Acetic Acid.

Pumps.
Photographic Articles.
Speaking Tubes, Mouthpieces.
Battery Cells.
Sheet and Rod.
Surgical Appliances.

GUTTA-PERCHA.

Tubing, Belting, Buckets, Bosses for Flax Spinning, &c.

Works: SILVERTOWN, ESSEX, LONDON, E.; PERSAN-BEAUMONT, FRANCE.
London Office—106, CANNON STREET, E.C.
Warehouse—100, CANNON STREET, E.C.

BRANCH WAREHOUSES:

BOOTLE	70, Regent Road.
LIVERPOOL	52, Castle Street.
GLASGOW	8, Buchanan Street.
BRADFORD YORKSHIRE	35, Kirkgate.
SHEFFIELD	64a, High Street.
PORTSMOUTH	49, High Street.
BELFAST	33, High Street.
DUBLIN	15, St. Andrew Street.
BRISTOL	2, Clare Street.
NEWPORT, MON.	32, Dock Street.
CARDIFF ...	Pierhead Chambers, Bute Docks.
NEWCASTLE-ON-TYNE ...	6, Neville Street.
NORTH SHIELDS	Borough Road.
BIRMINGHAM ...	Cobden Buildings, Corporation Street.
MANCHESTER	4, Fountain Street.
LEEDS	9, Trinity Street. 120

Printed by E. KNIGHT, 18 and 19, Middle Street, E.C., and Published by the Proprietors, H. ALABASTER, GATEHOUSE & Co., at 22, Paternoster Row, London.

Why go on using closed iron circuits when a

"HEDGEHOG"

TRANSFORMER

Costs half, and has a fifth of the waste of power?

SWINBURNE & Co.,

Broom Hall Works,
TEDDINGTON, ENGLAND.

Fireproof Cases Extra.

Lamps (30-w.)	H.P.	Price.			Lamps.	H.P.	Price.		
		£	s.	d.			£	s.	d.
2	..	2	2	0	200	8	20	0	0
4	...	3	5	0	250	10	24	0	0
12	...	4	4	0	300	12	30	0	0
25	1	5	10	0	400	16	35	0	0
50	2	8	18	0	500	20	40	0	0
100	4	12	15	0	750	30	55	0	0
150	6	17	17	0	1000	40	70	0	0

Sizes under 2 H.P. by the dozen only.

The two-lighter is a specialty for street lighting, price with case and brackets complete £2 12s, saving more than its cost in secondary leads.

Above 400 lights not stocked.

THE

INDIA RUBBER, GUTTA PERCHA, & TELEGRAPH WORKS

COMPANY, LIMITED.

Offices: 106, CANNON STREET, LONDON, E.C.

MANUFACTURERS OF

DYNAMO MACHINES,

INSULATED ELECTRIC LIGHT WIRES AND CABLES,

Lamp Fittings, Switches and Testing Apparatus, Volt and Ampere Meters.

CONTRACTORS FOR THE SUPPLY AND FITTING UP OF

ELECTRIC LIGHT APPARATUS

OF EVERY DESCRIPTION.

INSTALLATIONS FOR CENTRAL STATIONS, SHIPS, HOUSES, OR FACTORIES.

ESTIMATES ON APPLICATION.

Works: SILVERTOWN, LONDON, E. 839

THE

LONDON ELECTRIC WIRE COMPANY,

ANCHOR WORKS, PLAYHOUSE YARD, GOLDEN LANE, LONDON E.C.

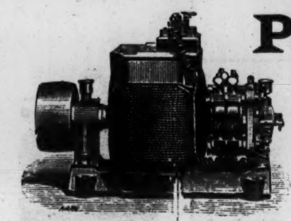
Manufacturers of

COVERED WIRES & CABLES

OF ALL DESCRIPTIONS

FOR ELECTRICAL INSTRUMENTS, ELECTRIC LIGHTING,

BELL AND TELEPHONE WORK, &c. 777



PRICE, TALBOT & CO., Ltd.,

26, LUDGATE HILL, LONDON, E.C.,

ELECTRICAL ENGINEERS, PNEUMATIC AND ELECTRIC BELL FITTERS AND MAKERS TO HER MAJESTY'S OFFICE OF WORKS.

Sole Agents and Manufacturers of McClellan's Patent Continuous Action Bells and Relays.

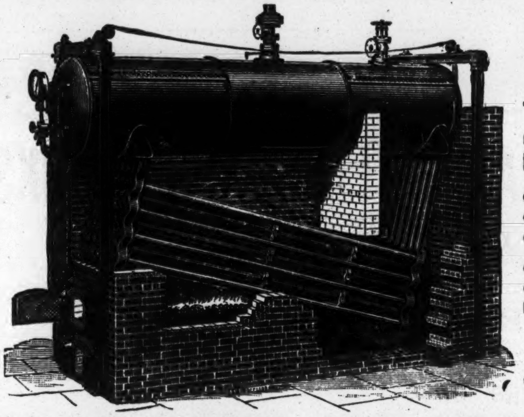
CATALOGUES AND ESTIMATES FREE. 3681

MOTORS, DYNAMOS, AMPEREMETERS, VOLTMETERS, and all APPARATUS connected with ELECTRIC LIGHTING SUPPLIED ON SHORTEST NOTICE.

THE BABCOCK & WILCOX CO.

PATENT

WATER-TUBE STEAM BOILER.



Over 500,000 H.P. in use.

Specially adapted and generally used for

ELECTRIC LIGHTING PURPOSES,

Because of their Great Economy in Fuel, Safety from Explosion, Durability; but principally their Entire Reliability.

The Edison Company have in use upwards of 10,000 H.P. of these boilers in all parts of the world. An important installation may be seen at work at the Grosvenor Gallery, London. The Societa Anglo-Romana, per l'Illuminazione di Roma, have had in use, for a considerable period, some 1,400 H.P. They may be seen, also, at work at the installation of the Societa per l'Illuminazione Elettrica, Palermo, Sicily, &c., &c. The Imperial Continental Gas Association, Vienna, is having erected an important installation of these boilers in connection with the lighting of the Grand Opera House in Vienna.

In connection with ELECTRIC LIGHTING, the reliability that can be placed on these boilers has led to their preference over others, and has ensured the large and increasing trade of the Company.

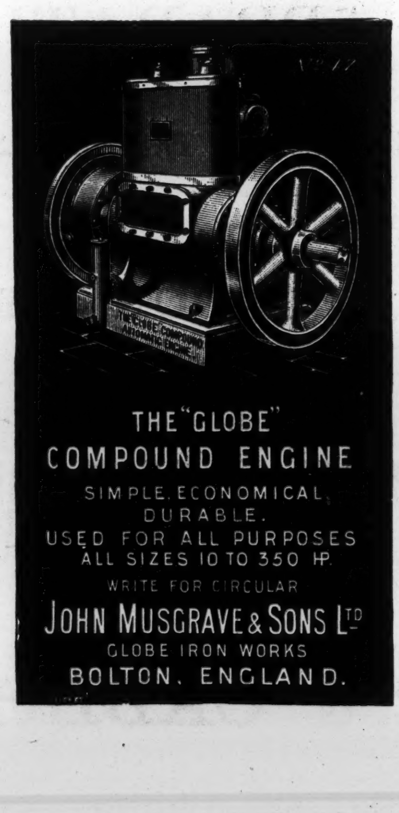
A VALUABLE BOOK ON STEAM FREE ON APPLICATION.

European Works: KILBOWIE, near GLASGOW.
Head Office for Europe: 21, Bothwell St., GLASGOW.
London Office: 114, NEWGATE STREET, E.C.

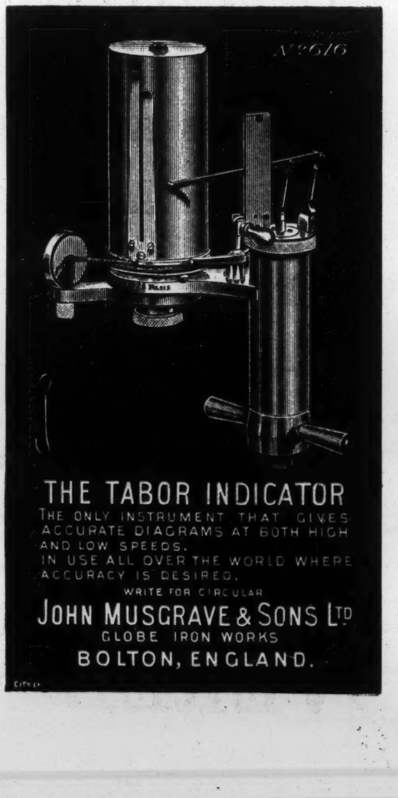
Manchester Office: 28, DEANSGATE. Paris office: 15, RUE DE LA CHAUSSÉE D'ANTIN. Brussels: 14, PLACE DE BROUCKERE, BRUSSELS.

FOR AUSTRALIA AND NEW ZEALAND, ADDRESS—

THE BABCOCK & WILCOX CO., 280, Sussex Street, SYDNEY, N.S.W. 2852



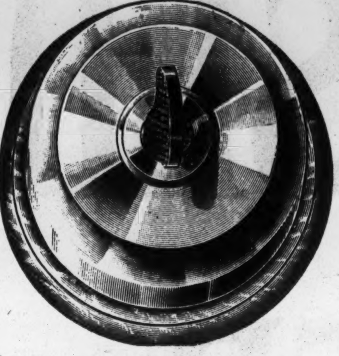
THE "GLOBE"
COMPOUND ENGINE
SIMPLE, ECONOMICAL, DURABLE.
USED FOR ALL PURPOSES
ALL SIZES 10 TO 350 HP.
WRITE FOR CIRCULAR
JOHN MUSGRAVE & SONS L^TD
GLOBE IRON WORKS
BOLTON, ENGLAND.



N°2616
THE TABOR INDICATOR
THE ONLY INSTRUMENT THAT GIVES ACCURATE DIAGRAMS AT BOTH HIGH AND LOW SPEEDS.
IN USE ALL OVER THE WORLD WHERE ACCURACY IS DESIRED.
WRITE FOR CIRCULAR
JOHN MUSGRAVE & SONS L^TD
GLOBE IRON WORKS
BOLTON, ENGLAND.

THE PAISTE SWITCH.

Record: 100,000 in daily use.



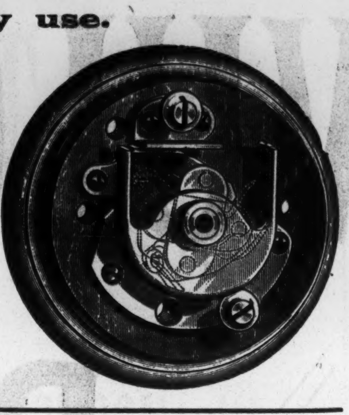
The movement breaks and completes the circuit in an instantaneous manner, preventing arcing or charring of the contact parts. Mounted on China, with cover and handle of same material; also on Porcelain, with metal cover. Correspondence invited.

◆◆◆◆◆◆◆

A. REYROLLE,

10, UNION MEWS, UNION STREET, MIDDLESEX
HOSPITAL, LONDON, W.

3866



THE

SUNBEAM LAMP CO.,

LIMITED,

GATESHEAD-ON-TYNE.

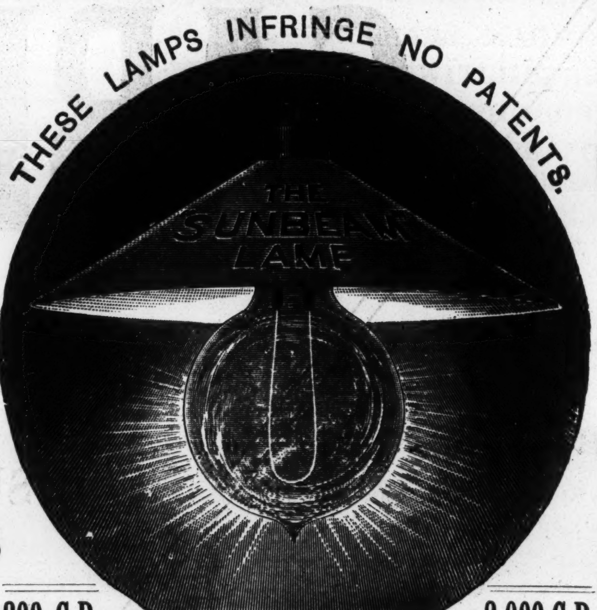
THESE LAMPS INFRINGE NO PATENTS.

NEWCASTLE-UPON-TYNE-ROYAL MINING, ENGINEERING & INDUSTRIAL EXHIBITION
1887
QUEEN'S JUBILEE YEAR

SILVER MEDAL,
Newcastle Exhibition,
1887.

SOLE MAKERS OF
"SUNBEAM"
INCANDESCENT LAMPS

London Address:
121, FENCHURCH ST., E.C.



200 C.P.

2,000 C.P.

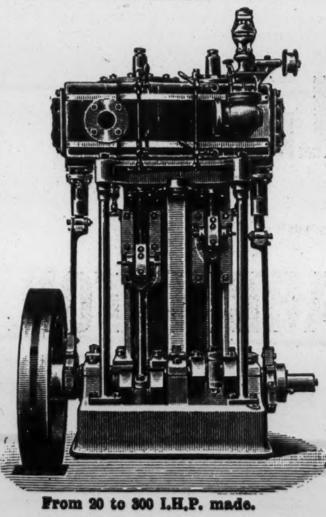
SILVER MEDAL,
PARIS EXHIBITION,
1889.

PRICES AND PARTICULARS ON APPLICATION.

Telegraphic Addresses:
"SUNBEAM, GATESHEAD."
"CYCLOPS, LONDON."

LOW RESISTANCE.

3123



VERTICAL COMPOUND HIGH-SPEED ENGINE, C. S. TYPE.

From 20 to 300 I.H.P. made.

ELECTRIC LIGHT ENGINES.

Over 150 Installations,

INCLUDING

STEAM SHIPS, WAR VESSELS, FACTORIES, MANSIONS, AND CENTRAL STATIONS,

HAVE BEEN ENGINED BY

BROWETT, LINDLEY & CO.,

SANDON ENGINE WORKS,
SALFORD, **MANCHESTER.**

Patentees and Sole Makers of the **ACME GOVERNOR**. Hundreds are in use for Electric Light Engines. Send for Lists.

3785

VULCANISED

RUBBER

CABLES

OF GUARANTEED

INSULATION

AND QUALITY.

THE TELEGRAPH MFG. CO., LD.,

HELSBY, NEAR WARRINGTON.

11, QUEEN VICTORIA STREET, LONDON. E.C.

3965

RONALD A. SCOTT, M.I.E.E.,

CONTRACTOR TO THE LORDS OF THE ADMIRALTY,
INDIAN GOVERNMENT, &c.,

ACTON HILL ELECTRICAL WORKS, LONDON, W.

MANUFACTURER OF

DYNAMOS, MOTORS, ARC LAMPS.
SEARCH LIGHT APPARATUS of every description.
SWITCHES.
CUT-OUTS—ORDINARY, MAGNETIC.
SCOTT'S PATENT SWITCHBOARDS.
" " LAMPHOLDERS.
" " MIRRORS FOR PROJECTORS—Unequalled.

NOTE.—Any of the above to be seen in stock at the Works, or in course of construction. The Acton Hill Works is the only Establishment in the Kingdom where Projectors of three sizes, fitted complete with lamp and mirror, can be obtained from stock.

ESTIMATES GIVEN FREE

For Wiring, Laying of Mains, or Fitting up Complete Installations with independent plant, consisting of Engines, Boilers, Accumulators, &c.

SPECIAL ATTENTION

Is drawn to the facility for supplying electrical plant at short notice, and of perfect workmanship. Owing to the possession of the most modern machinery and appliances and a trained staff urgent work can have the best attention.

✻ NOTE ✻

ELECTRICAL CONTRACTORS AND CONSULTING ENGINEERS are invited to send particulars of Specifications and Specialities required. Dynamos, Motors, and Electrical Apparatus built to Inventors' own instructions.

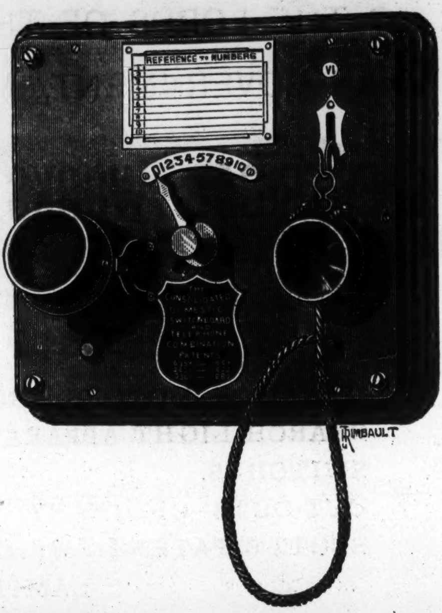
3674

TELEPHONES! TELEPHONES!

MAGNETO TRANSMITTERS AND RECEIVERS WITH BATTERY CALL.

EXPIRY OF BELL PATENT, 9th DECEMBER.

Specially adapted for connecting rooms in hotels and warehouses; private houses with stables, &c., &c.



FREE TELEPHONES.

FREE TELEPHONES.

For Free Telephones apply to—

THE CONSOLIDATED TELEPHONE CONSTRUCTION & MAINTENANCE CO., LTD.,
109, FARRINGDON ROAD, LONDON, E.C.

M. HOLROYD SMITH,

Crossley Street, HALIFAX, and 18, Abingdon St., WESTMINSTER,

ENGINEER DURING CONSTRUCTION OF

THE BLACKPOOL ELECTRIC TRAMWAY,

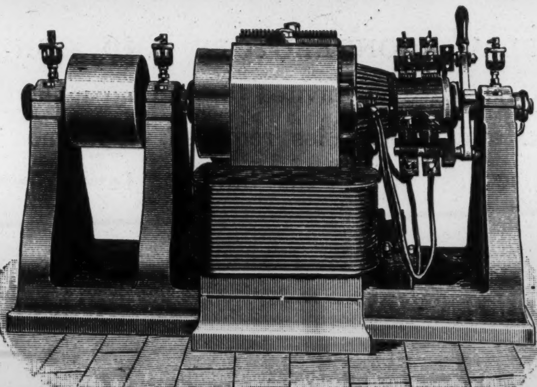
AND PATENTEE OF THE SYSTEM.

Contracts undertaken for equipping and working Railways or Tramways with Electricity by means of

UNDERGROUND CHANNELS, OR OVERHEAD CONDUCTORS.

3850

ANDREWS & PREECE, LTD.,



ELECTRICAL ENGINEERS & CONTRACTORS,

MANUFACTURERS OF THE

"PREECE" DYNAMO.

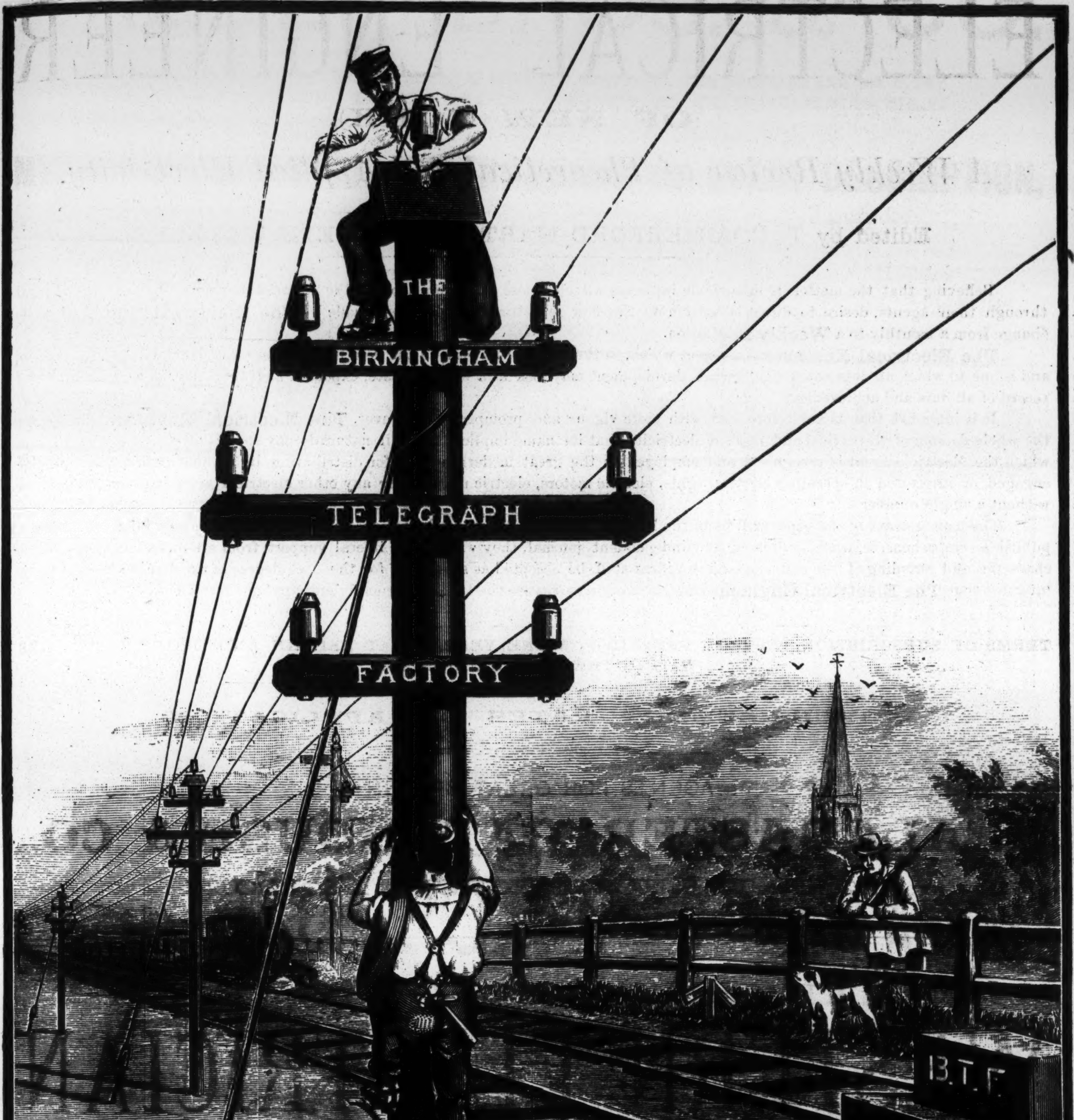
ARC LAMPS, SWITCHES, &c.

Estimates and Specifications prepared free of charge on application.

BOROUGH MILLS, MANCHESTER ROAD,
BRADFORD.

3826

NEW PATTERNS! NEW MACHINERY!



THE
BIRMINGHAM
TELEGRAPH
FACTORY
B.T.F.
B.T.F.
B.T.F.
THE BIRMINGHAM No 753 TELEGRAPH FACTORY
THE BIRMINGHAM TELEGRAPH FACTORY No BIRM
Del.

J. SLATER LEWIS,

THE BIRMINGHAM TELEGRAPH FACTORY,

BIRMINGHAM.

(Late Managing Director and Engineer of the Telegraph Mfg. Co.)

Telegrams: "INSULATOR, BIRMINGHAM." TELEPHONE, 409.

THE

ELECTRICAL ENGINEER

(OF NEW YORK).

A Weekly Review of Theoretical and Applied Electricity.

Edited by T. COMMERFORD MARTIN and JOSEPH WETZLER.

Believing that the matter is one which interests all electrical engineers closely, the proprietors and editors of this journal through their agents, desire to direct attention to the new departure that has been made by **The Electrical Engineer** in its change from a monthly to a **Weekly** publication.

The Electrical Engineer is a paper, which, as the oldest of its class in the field in America, has a distinguished reputation, and is one to which all interested in electrical development may look as a safe advocate, exponent and authority, as well as a faithful record of all data and achievement.

It is intended that as heretofore, but with more vigour and promptness than ever, **The Electrical Engineer,** shall cover the whole domain of theoretical and applied electricity that its name implies. It will naturally pay special attention to the work in which the electric current is recognised and employed as the great modern agency for distributing light, heat and power. No one engaged, or interested in operating electric lights, electric motors, electric railways, or any other electrical apparatus can afford to be without a single number.

The management of the paper will be in the hands of the above named, who believe that in the endeavour and determination to publish a comprehensive, useful, unbiased and independent journal, they will receive liberal support from all quarters. Should the character and standing of the editorial and business staff be accepted as a warrant for the high degree of excellence aimed at, it is intended that **The Electrical Engineer** shall in every way realise the kind and friendly anticipations formed respecting it.

TERMS OF SUBSCRIPTION, POSTAGE PREPAID FOR ONE YEAR, GREAT BRITAIN AND OTHER COUNTRIES WITHIN THE POSTAL UNION, 20s.

ADVERTISEMENT RATES ON APPLICATION.

AGENTS FOR GREAT BRITAIN:

H. ALABASTER, GATEHOUSE & CO.,

22, PATERNOSTER ROW, LONDON.

THE

WESTERN ELECTRICIAN

(OF CHICAGO).

A Weekly Paper of Electrical Science.

"This excellent and well-illustrated journal has rapidly pushed its way into the front rank of electrical papers, and does for the Western States what the *Electrical Engineer* is so ably doing for the Eastern States of America. It is early with its information, bright and clever in its views, and in its expression of them independent."

TERMS OF SUBSCRIPTION, POSTAGE PREPAID FOR ONE YEAR, GREAT BRITAIN AND OTHER COUNTRIES WITHIN THE POSTAL UNION, 20s.

ADVERTISEMENT RATES ON APPLICATION.

AGENTS FOR GREAT BRITAIN:

H. ALABASTER, GATEHOUSE & CO.,

22, PATERNOSTER ROW, LONDON.

TELEPHONE 3120. Telegraph Address: "SECOHM, LONDON."

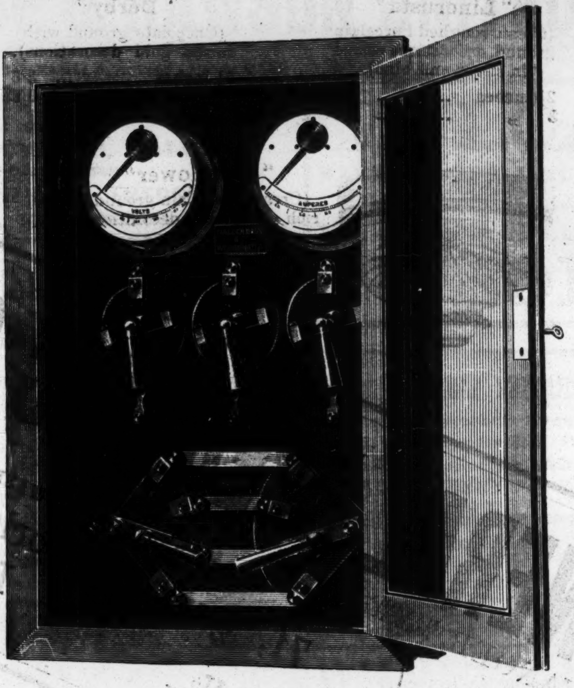
NALDER BROS. & CO.

Present Address:—132, HORSEFERRY ROAD, WESTMINSTER;
Shortly Removing to 16, RED LION STREET, CLERKENWELL
(Two Minutes' walk from Farringdon Street Station).

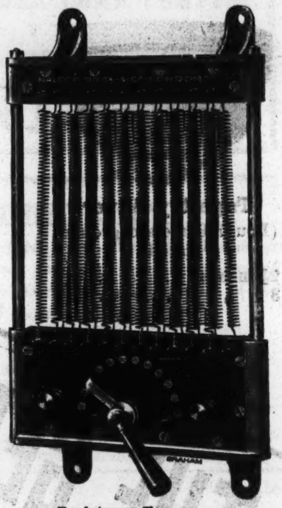
MEASURING & TESTING INSTRUMENTS OF EVERY DESCRIPTION,

Switchboards, Resistance Frames, Ammeters & Voltmeters for all purposes.

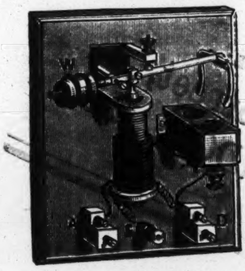
Alternate Current Ammeter.



Holmes' Patent Automatic Switch for Battery Charging.



Resistance Frame.



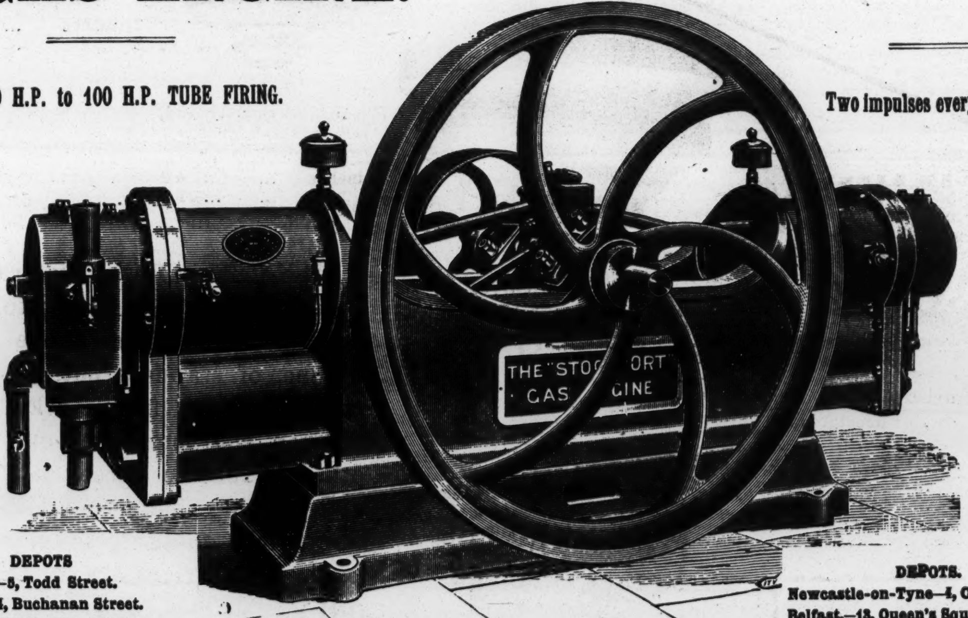
Holmes' Patent Automat

THE "STOCKPORT" DOUBLE ACTING GAS ENGINE.

Type of Engine 24 H.P. Nominal.

SIZES:—20 H.P. to 100 H.P. TUBE FIRING.

Two impulses every revolution.



DEPOTS
Manchester.—5, Todd Street.
Glasgow.—134, Buchanan Street.
Dublin.—62, Middle Abbey Street.

DEPOTS.
Newcastle-on-Tyne—4, Cloth Market.
Belfast.—13, Queen's Square.
Liverpool.—28, North John Street.

THE SIMPLEST GAS ENGINE MADE.

SPECIALLY ADAPTED FOR ELECTRIC LIGHTING.

London Office.—80, QUEEN VICTORIA ST., E.C. 3504

ANDREW & Coy., Ltd., REDDISH, STOCKPORT.

DECORATED CEILING ROSES,

H.I. TYPE.

"Star"
(Cream Porcelain ground, gold lines and stars).

2½ inches	4/9
3	5/5

"Lincrusta"
(Cream roughed Porcelain ground, decorations raised in silver and blue).

2½ inches	5/6
3 ,, ...	6/8

"Derby"
(Chocolate ground with raised gold decorations).

2½ inches	5/6
3 ,, ...	6/8

Plain Silver
Porcelain plated over.

2½ inches	5/6
3 ,, ...	6/8

Tapestry Silver
(Rough Porcelain, ground, plated).

2½ inches	5/6
3 ,, ...	6/8

"Cornflower"
(Cream Porcelain ground, rich gold raised decoration).

2½ inches	5/-
3 ,, ...	5/8

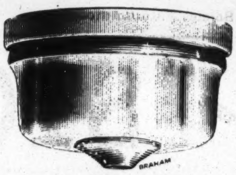
THE GENERAL ELECTRIC Co., Ltd.

(G. BINSWANGER, MANAGING DIRECTOR.)

HEAD OFFICE AND WAREHOUSE:—
71, Queen Victoria Street,
LONDON, E.C.

WORKS:—
45, CHAPEL STREET, SALFORD,
MANCHESTER.

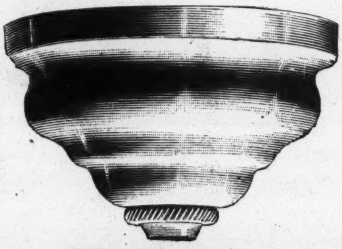
Branch Office:— 7, BOTHWELL ST.,
GLASGOW.


Plain Brass Cover
Spun over Porcelain.

2½ inches	2/3
3 ,, ...	2/7

"Key"
(Cream Porcelain ground, rich gold and crimson raised decoration).

2½ inches	4/9
3 ,, ...	5/5


Plain Brass Cover
Over Porcelain base, held in position by top ring).

3 inches	2/0 each.
4 ,, ...	3/0 ,,
5 ,, ...	4/0 ,,

"Burlington"
(Porcelain base, ornamental brass cover).

3 inches	7/6 each.
4 ,, ...	12/0 ,,
5 ,, ...	17/6 ,,

The Ceiling Roses illustrated on this page can be supplied to match any pattern. The above are a number of standard patterns which can be supplied from stock, and are of such character that one or the other is sure to agree with almost any design, shade, or decoration. The prices quoted below the three larger illustrations are for COVERS ONLY.

....

FOR FURTHER PARTICULARS SEE

5th Edition

CATALOGUE.

ALL
ELECTRICAL
SUPPLIES.

"Beaufort"
(Porcelain base, very artistic, brass cover).

3 inches	10/6 each.
4 ,, ...	17/6 ,,
5 ,, ...	25/0 ,,

THE "CASTLE" DYNAMOS AND MOTORS

SLOW SPEED HIGH EFFICIENCY BEST WORKMANSHIP

PATENT ARC LAMPS, SWITCHES ETC.

J. H. HOLMES & Co.,
NEWCASTLE-ON-TYNE
& 74, Coleman Street, LONDON E.C.

2862

WOODHOUSE & RAWSON UNITED, LD., See Pages 7 & 13. 3871

TELEPHONE: 1888. TELEGRAMS: "INDICES," LONDON.

WHEATLEY KIRK, PRICE & GOULTY,
(Established 1850),
ELECTRICAL AUCTIONEERS, VALUERS AND ARBITRATORS,
52, QUEEN VICTORIA STREET, LONDON, E.C.,
And Albert Square, MANCHESTER. 1542

THE ELECTRIC & GENERAL INVESTMENT CO.,

LIMITED,

Offices:—1 & 2, Great Winchester Street, London, E.C.

His Grace the DUKE OF MARLBOROUGH, Chairman.

The Company has been formed FOR THE PURPOSE OF FACILITATING THE PROMOTION AND DEVELOPMENT OF UNDERTAKINGS for Electric Lighting, Traction, Transmission of Power, and other industrial uses of electricity.

Communications may be addressed to—

J. CECIL BULL,
Secretary.

3827

PATENTS, DESIGNS, AND TRADE MARKS' ACTS, 1883.

NOTICE is hereby given that Edward Manville, of 11, Queen Victoria Street, City, London, has applied for leave to amend the Specification filed in pursance of the application for Letters Patent, No. 9,745, of 1888, for "An improved system for driving moving electric motors or locomotives in series."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on the 12th November, 1890.

Any person may give notice (on Form G.) at the Patent Office, 25, Southampton Buildings, London, W.C., of opposition to the amendment within one month from the date of the said Journal.

(Signed) H. READER LACK,
Comptroller General.

Fell & Wilding,
1, Queen Victoria Street, London, E.C.,
Agents for the Applicant.

MUNICIPALITY OF BOMBAY.

ELECTRIC LIGHTING.

NOTICE.

SEALED TENDERS will be received by the Municipal Commissioner for the City of Bombay up to 1 p.m., on Monday, the 16th day of February, 1891, for experimental lighting by electricity of certain streets of the City of Bombay for a period of two years.

Forms of Tender and schedule of conditions and a sketch of the portion of the City, showing the streets to be lighted may, on payment of £1 sterling, be obtained from Messrs. E. W. & R. Oliver, 1, Corbet Court, Gracechurch Street, London, E.C., who will on application give any further information that may be required.

Tenders must be accompanied by a deposit of Rupees 1,000 in cash (not to bear interest) or in public securities for that amount to be paid to the Chief Accountant of the Municipalty of Bombay, which will be forfeited to the Corporation in case of refusal to sign the contract embodying the conditions mentioned in the schedule above referred to.

A further payment to make the total deposit equivalent to 5 per cent. on the contract amount will have to be made by the Tenderer whose tender may be accepted, before signing the contract.

The Municipal Commissioner does not bind himself to accept the lowest or any tender.

By order of the Municipal Commissioner,

RIENZI WALTON,
Executive Engineer, Municipality.

Executive Engineer's Office,
Bombay Municipality, Bombay,
13th October, 1890.

4075

VULCANITE.

HARBURG INDIA-RUBBER COMB COMPANY.
London Warehouse: F. WINTER,
188, LONDON WALL WOOD STREET E.C.

EBONITE. 1710

CHEAP PREPAID ADVERTISEMENTS,

Relating to *Situations Vacant, Situations Wanted, Businesses Wanted, Businesses for Sale, Patents for Sale, Specific Articles of any kind Wanted, or for Sale or Exchange, are inserted at the rate of* ONE PENNY *Per Word (minimum 1s.).*

Three consecutive Insertions for the Price for Two.

⁂ This Scale does not apply to Trade Advertisements, terms for which can be had on application.

WANTED, a Foreman Wireman for flexible and G.P. manufacture.—Apply to 4,091, Electrical Review Office. 4091

WANTED immediately, a young man to test and calibrate electrical instruments, with a good technical knowledge.—Apply to No. 4,090, Electrical Review Office. 4090

AS MANAGER, Superintendent or Resident Engineer. A practical engineer desires position as above. Has had a wide electrical engineering experience at home and abroad in the service of leading firms. Had good mechanical training before taking up electricity. Well versed in the design, construction and testing of direct driving engines, dynamos, motors, search light projectors, switches, and electrical plant generally. Has superintended erection of ship work and installations ashore. Age 30, well educated, good address, accustomed to meeting clients.—Address 4,095, Electrical Review, 22, Paternoster Row, London. 4095

APPOINTMENT required by Electrical Engineer, four years' experience. Arc and incandescent wiring, theoretical knowledge.—Apply 4,092, Electrical Review Office. 4092

ELECTRICAL ENGINEER wishes to meet with appointment with good firm of electrical engineers, with a view to partnership.—Address 4,094, office of Electrical Review. 4094

ELECTRICAL ENGINEER open for engagement. 10 years with leading firms; four years on central station work; accustomed to underground or overhead high-tension parallel systems; at present in sole charge of supply station, and all house wiring connected.—4096, Electrical Review, 22, Paternoster Row, London. 4096

PRACTICAL electrical and mechanical engineer seeks engagement. Experienced in design and manufacture of dynamos, fittings, &c., and in installation work. Has had four years' management of works, and is used to estimating, age 25, moderate salary.—"W.," 7, Beaumont Road, Hornsey Rise, London, N. 4086

ADVERTISER (25), abstainer, desires to learn mechanical and electrical engineering.—"R," 3, Fern Terrace, Southboro', Tunbridge Wells. 4087

ELECTRICAL ENGINEER desires engagement. Good references from last place; well up in arc, incandescent, ship lighting, search lights; home or abroad.—Address "A. S.," office of this paper. 4067

CORRESPONDENT.—Re-engagement wanted in a first-class electrical establishment by an experienced German gentleman (25) of the line, perfect correspondent in English, French, German and Italian. Best references.—Apply 4,055, Electrical Review office. 4055

ADVERTISER SEEKS SITUATION on Telephone or Lighting Station as improver, or otherwise. College training. Good references.—Address, "Megohm," Electrical Review Office. 4042

[*Continued on next Page.*]

ENGINE DRIVER requires situation driving electric light engines; used to all kinds. Highest references for soberness, careful driving and respectability.—"A. C.," 4, Wrigglesworth Street, New Cross, S.E. 4083

WANTED.—Complete Volume 20 ELECTRICAL REVIEW (January to June, 1887). 1s. will be paid for copies of May 11, 1888.—Address 2,000, ELECTRICAL REVIEW, 22, Paternoster Row, London. 2000

FOR SALE, dynamo, a Gramme in good condition, £16; by letter.—E. COVERLY, 43, Bakers Row, Whitechapel. 4084

FOR SALE.—20 Shares in the Gülcher (New) Electric Light Company.—Offers to 4,097, ELECTRICAL REVIEW Office, 22, Paternoster Row. 4097

DYNAMO FOR SALE.—100-light Brush-Victoria shunt wound. Can be seen running in London. Recently had new armature. Also quantity of shafting, plummer blocks, pulleys, &c.—HARRY SOUTH, 10 & 12, Garrick Street, Covent Garden, W.C. 4010

BEFORE ORDERING Electrical Plant and Accessories, Write for Pamphlets to the ELECTRICAL ENGINEERING CORPORATION, LIMITED: "Electrical Distribution," "Machine Driving by Electricity," "The Telpher System of Cheap Transport," and "Electrical Supplies."—68, Victoria St., Westminster. 3348

ELECTRIC LIGHTING BUSINESS for disposal, old established and profitable. Good connection. Makers of a well-known type of dynamos and lamps. Satisfactory reasons for disposal.—Write, 46, Call Lane, Leeds. 4085

ELECTRICITY.—MONTALVO and HERRÁN, Bogotá, (Republic of Colombia, South America), Merchants (in every description of Electrical Apparatus and all kinds of goods relating to Electricity), ask prospectuses and price lists and accept consignments.

TO ELECTRIC ENGINEERS. Tenders required for supplying and fixing electric call bells to firemen's houses. The lowest or any tender not necessarily accepted.—Full particulars, on application, to E. W. REES, Pontypridd. 4061

ESTABLISHED 1869.

MANGANESE and CARBONS.

Specially prepared and Manufactured for every class of Electrical Work.

GEO. G. BLACKWELL.

Works: GARSTON. Chief Office: 25 & 27, Irwell Chambers, LIVERPOOL.

Telegrams: "BLACKWELL, LIVERPOOL." *TELEPHONE* 959. 4057

TURNER BROTHERS,

134, UPPER THAMES STREET, LONDON.

IRON AND STEEL.

Special Charcoal Iron Sheets for Dynamo Plates. Transformer Stampings and Discs. Soft Charcoal Iron Wire. Soft Wrought Iron Forgings for Magnets, also in Mild Steel. Mild Steel and Bessemer Steel Forgings for Shafting. Sheer Steel, Tool Steel, Files, &c. Brass and Copper Rods and Tubes. Wrought Iron and Steel Tubes for Electrical Conductors. Merchant Bar Iron and Steel, Hoops, Plates, Channels, &c. 4066

Mr. J. G. LORRAIN, M.I.E.E., M.I.M.E., &c.,

PATENT AGENT AND CONSULTING ENGINEER,

Norfolk House, Norfolk St., London, W.C.

"PATENTEE'S HANDBOOK" Post Free on Application. 4014

New Volume of Griffin's Scientific Text-Books,

FOR THE USE OF STUDENTS & PRACTICAL MEN.

THIS DAY.—With numerous Illustrations and Tables, large crown, 8vo., cloth, 10s. 6d.

ELECTRO-METALLURGY,

(A TREATISE ON).

Embracing the application of Electrolysis to the Plating, Depositing, Smelting, and Refining of various Metals, and to the Reproduction of Printing Surfaces and Art Work, &c.

By W. G. McMILLAN, late Demonstrator of Metallurgy, King's College, London, Chemist and Metallurgist to the Government Factory, Cossipore.

MAGNETISM AND ELECTRICITY

(AN ELEMENTARY MANUAL OF).

With Examination Questions and numerous Illustrations.

By Prof. A. JAMIESON, M.Inst. C.E., Glasgow Technical College.

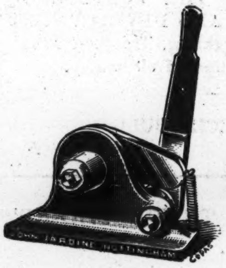
Part I. Magnetism, 1s.; Part II. Voltaic Electricity, 1s. 6d.; Part III. Electro-Statics, or Frictional Electricity, 1s. 6d.; or complete in cloth, 3s. 6d.

"Teachers are to be congratulated on having such a thoroughly trustworthy Text-Book at their disposal."—*Nature.*

London: CHARLES GRIFFIN & Co., Exeter Street, Strand.

NATIONAL TELEPHONE COMPANY, LIMITED.

A TRUNK Line Call Box is opened at Oxford Court, Cannon Street, E.C., for conversation with Exchange Subscribers in Manchester, Liverpool and Birmingham. The charge for three minutes' conversation to Manchester or Liverpool is 3s., and to Birmingham 1s. 6d. 4093



Telegraphic Address: "JARDINE, NOTTINGHAM."

TELEPHONE No. 295.

JOHN JARDINE,

NOTTINGHAM.

SMALL SHEARS

Designed for cutting off round rods without bruising the ends.

TAYLOR, TUNNICLIFF & CO.,

EASTWOOD, HANLEY,

Manufacturers of

PORCELAIN PARTS FOR

LAMP HOLDERS, CEILING ROSES,

SCREWED SWITCH BASES AND COVERS,

CUT-OUTS,

SAFETY JUNCTIONS.

And Specialities for Electric Lighting. 3977

R. McGOUNE, BUCHANAN & Co.

WHOLESALE MICA MERCHANTS,

9, Mincing Lane, London, E.C.

Telephone No. 11,147. *Telegrams, "Boulanger."*

MICA

For Electrical and all other purposes.

Samples and Quotations on receipt of Patterns and Specifications.

Special Department for Chemicals used by Electricians.

ELLIOTT BROTHERS,

101 & 102, ST. MARTIN'S LANE, LONDON, W.C.

(ESTABLISHED 1800).

ELECTRICAL ENGINEERS AND MANUFACTURERS OF ALL KINDS OF ELECTRICAL TESTING AND TELEGRAPH INSTRUMENTS.

SUBMARINE MINING APPARATUS, &c. CONTRACTORS TO H.M. GOVERNMENT.

Highest Award Paris Exhibition 1889. Only "Grand Prix" to any English Electrical Exhibit.

Telegraph Address: "OHM," LONDON. Telephone No. 3852. 3509

Telephone No. 3125.

SHARP & KENT,
34, VICTORIA STREET,
WESTMINSTER, AND BRANCHES.

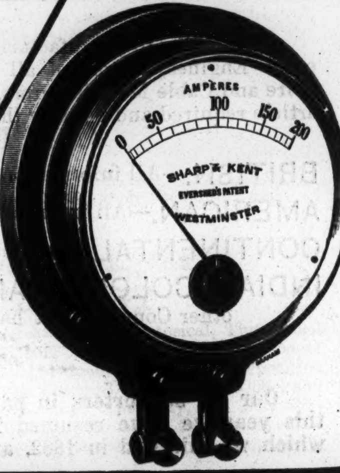
NEW PRICE LIST NOW READY.

AMMETERS
and
VOLTMETERS

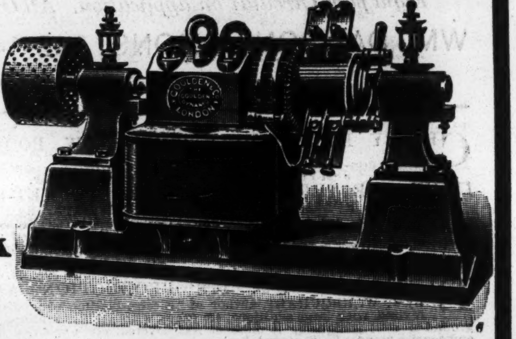
For Engine Room use,
Alternating or
Direct Current.

MARINE TYPE
For Ship,
Tram,
Train use.

Telegrams:
"MEGAVOLT,"
LONDON.



GOOLDEN & Co.,
Contractors to English & Foreign Governments,
Railways, Central Stations, &c.



Standard Goolden Overtype Dynamo, built with Gramme, Drum and Bar Armatures.
HAVE BEEN BUILT IN ALL SIZES,
Some weighing over SEVEN TONS without Engine.
Dynamos of this type have worked at 350 volts, transmitting power in Mines (a severer test than lighting) for some years without a penny being spent in repairs.

DYNAMOS. Splendid Mechanical Construction.
Armatures insulated entirely with MICA
Armatures and Field Coils VENTILATED INSIDE.
Long Bearings. Clean and Economical Lubrication.
CHEAPER than any Dynamos working with same MARGINAL FACTORS and at same LOW TEMPERATURE.

POSITIVE DRIVING of Conductors.

AMPLE CLEARANCE for Armatures.

MOTORS
STRONGLY BUILT.
Will drive machinery direct with Spur Gearing, without breaking down the armatures.
HIGH EFFICIENCIES.

STEAM DYNAMOS
FOR ANY OUTPUT.
DYNAMOS and MOTORS
Built to Specification

STEAM DYNAMO for ELECTROTYPING supplied to Ordnance Survey Dept.

WOODFIELD WORKS, HARROW ROAD,
LONDON, W.

10 H.P. Launch Motor with Goolden Watertight Armature; will work with Armature in water.

TENTH YEAR OF PUBLICATION.

WM. DAWSON & SONS have pleasure in drawing your attention to the TENTH ANNUAL PUBLICATION OF

J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

FOR 1891.

THE LEADING ELECTRICAL TRADES DIRECTORY OF GREAT BRITAIN,

And the OLDEST ELECTRICAL DIRECTORY in the WORLD.

Invaluable to Manufacturing Electricians, Electrical Engineers and Contractors, Makers of High Speed and other Engines, Motors of all kinds, Driving Bands, Carbons, Chemicals, Insulators and Insulating Materials, Wire and Cable Manufacturers, Wholesale and Retail Dealers in Electrical Goods, and to Manufacturers of any article required and used by the Electrical Trades. No office is complete without a copy.

ARRANGED IN SECTIONS, AS FOLLOWS, VIZ.:—

BRITISH.—All information relating to Great Britain and Ireland.

AMERICAN.—All information exclusive of the British possessions.

CONTINENTAL.—All information relating to the Continent.

INDIAN, COLONIAL AND GENERAL.—All information relating to British Possessions, including other Countries not having a Special Section.

SPECIAL NOTICE!

Our old supporters in particular and Advertisers and Subscribers in general, are desired to note, that this year we have resumed THE SAME METHOD OF CANVASSING BY SPECIAL CIRCULAR (8 pages) which we initiated in 1882, and used continuously until 1886.

Eight page Circular on application. All Orders for Advertisements, Books and Insertions to be forwarded to

WM. DAWSON & SONS, 148-149, UPPER THAMES STREET, LONDON, E.C.

(We have no other Office.)

CROSBY LOCKWOOD & SON'S NEW BOOKS.

Just Published, Royal 32mo. oblong, 5s. leather.

THE ELECTRICAL ENGINEER'S POCKET-BOOK OF MODERN RULES, FORMULÆ, TABLES, AND DATA. By H. R. KEMPE, M.Inst.E.E., A.M.Inst.C.E., Technical Officer Postal Telegraphs. "This is a good book."—*Electrician.* "Strongly recommended to those engaged in the various electrical industries."—*Electrical Review.* "It is the best book of its kind."—*Electrical Engineer.*

Fourth Edition, much Enlarged. Just Published, Crown 8vo., 7s. 6d., Cloth.

ELECTRIC LIGHT: ITS PRODUCTION AND USE. By J. W. URQUHART, author of "Electro-Plating," &c. Fourth Edition, revised, with large additions, 420 pages, with 147 Illustrations. "The whole ground of electric lighting is more or less covered, and explained in a very clear and concise manner."—*Electrical Review.*

Just Published, Crown 8vo., 5s., Cloth.

ELECTRIC LIGHT FITTING. A Handbook for Working Electrical Engineers. By J. W. URQUHART. "A really capital book, which we recommend to the notice of working electricians and electrical engineers."—*Mechanical World.*

Third and Cheaper Edition. Just Published, 8vo., 6s., Cloth.

FACTORY ACCOUNTS: THEIR PRINCIPLES AND PRACTICE. A Handbook for Accountants and Manufacturers, including a large number of Specimen Rulings. By E. GARCKE and J. M. FELLS. "The authors are thorough masters of their subject. Abounds in valuable suggestions."—*St. James's Gazette.*

London: CROSBY LOCKWOOD & SON, 7, Stationers' Hall Court, E.C. 4025

ESTABLISHED 1880.

THE

Railway Engineer

An Illustrated Monthly Review of the Construction, Machinery and Administration of Railways.

MONTHLY, ONE SHILLING.

A Valuable Work for Reference, illustrated with large

LITHOGRAPHED WORKING DRAWINGS

Of Locomotives and other Rolling Stock; Bridges and all kinds of Railway Appliances.

ANNUAL SUBSCRIPTIONS, IN POSTAL UNION, 14s.

(Payable in Advance, including Postage.) Specimen Copy Post Free, 1s.

OFFICES:—8, CATHERINE ST., STRAND, LONDON, W.C.

ELECTRICAL REVIEW.

BINDINGS AND CASES.—Subscribers and others can have their half-yearly numbers bound handsomely in Black Cloth at the rate of 3s. 6d. per volume. Cases for binding are also supplied at 2s. 6d. each.—22, PATERNOSTER ROW, LONDON.

THE

DAILY ORACLE

ESTABLISHED 1889.

Published Every Morning.

PRICE ONE PENNY.

AN INDEPENDENT FINANCIAL NEWSPAPER.

DEVOTED TO THE INTERESTS OF SHAREHOLDERS AND INVESTORS.

IT CONTAINS:

FULL CRITICISMS ON NEW COMPANIES, MEETINGS, &c.,

LATEST PRICES OF QUOTED AND UNQUOTED SECURITIES,

MINING, INSURANCE, PRODUCE & SPORTING NOTES,

DAILY EXTRACTS FROM THE REGISTER OF BILLS OF SALE AND DEEDS OF ARRANGEMENT,

SHIPPING INFORMATION.

Scale of Charges for Advertisements can be had on application.

AT ALL NEWSAGENTS AND BOOKSTALLS.

Offices: 20, BUCKLERSBURY, LONDON, E.C.

Publications.

French Morocco, Gilt, Pocket Size, 4¾ in. by 3 in., 4s. 6d., Post Free. 130 Illustrations and Diagrams. 2nd Edition, Revised and Enlarged By W. PERREN MAYCOCK, A.M.Inst.E.E.

PRACTICAL ELECTRICAL NOTES AND DEFINITIONS.

For the Use of Engineering Students and Practical Men.

Conductors, Lightning Conductors and Electric Light Wiring Systems; Circuits, Ohm's Law and Units, Definition of Units; Magnetism; Batteries, Electrolysis and Thermo-Electricity; Bells, Indicators, Switches, Alarms, &c.; Electric Lighting, Dynamos, Transformers, Lamps; Telegraphs, Telephones, Signal Codes, Electric Clocks; Electric Transmission of Power, Electric Railways, Motors, Telpherage; Rules and Regulations to be observed in the fitting up of Electrical Installations, Phœnix Rules, Electrical Engineers (Institution of) Rules.

Cloth, 7s. 6d., Post Free. 4th Edition, Revised and Enlarged. Numerous Illustrations. By JOHN W. URQUHART.

ELECTRIC LIGHT; ITS PRODUCTION AND USE.

Plain Directions for the Treatment of Dynamo-Electric Machines, Batteries, Accumulators and Electric Lamps; Primary and Secondary Batteries; Thermo-Electric Batteries; Magneto-Electric Generators; Electro-Magneto Electric Machines, Dynamo-Electric Machines; General Observations on Machines, Transformers, and Electricity, Meters, Arc and Incandescent Lamps; Electrical Distribution and Circuits; Measurement of the Arc Light; Mathematical Notes; Present Application and Cost of the Electric Light; Notes on Ship Lighting; Electric Light Wiring Tests.

Cloth, 3s, 6d., Post Free. 177 Illustrations. By F. C. ALLSOP.

ELECTRIC BELL CONSTRUCTION.

A Treatise on the Construction of Electric Bells, Indicators and similar apparatus.

Electricity and Magnetism; Bells, Indicators, Relays and Continuous Ringing Attachments; the Magneto Generator and Bell; the Detector.

Cloth, 10s. 6d., Post Free. With Numerous Illustrations. By W. G. McMILLAN, F.I.C., F.C.S.

A TREATISE ON ELECTRO-METALLURGY.

The Application of Electrolysis to Art Work and the Refining of various Metals; Introductory and Historical, Theoretical and General, Source of Current; General Conditions to be observed in Electro-Plating; Plating Adjuncts and Disposition of Plant; the Cleansing and Preparation of Work for the Depositing Vat and subsequent Polishing of Plated Goods; the Electro-Deposition of Copper; Electro-Typing; the Electro-Deposition of Silver; the Electro-Deposition of Gold; the Electro-Deposition of Nickel and Cobalt; the Electro-Deposition of Iron; the Electro-Deposition of Platinum, Zinc, Cadmium, Tin, Lead, Antimony, and Bismuth; Electro-Chromy; the Electro-Deposition of Alloys; Electro-Metallurgical Extraction and Refining Process; the Recovery of Certain Metals from their Solutions or Waste Substances; the Determination of the Proportion of Metal in Certain Depositing Solutions; a Glossary of Substances Commonly Employed in Electro-Metallurgy, Addenda.

Cloth, 10s. 6d., Post Free. By G. GORE, LLD., F.R.S. (Author of the "Art of Electro-Metallurgy," &c., &c.)

THE ELECTROLYTIC SEPARATION OF METALS, &c.

THEORETICAL AND PRACTICAL.

Theoretical Division.—Historical Sketch; Chief Electrical Facts and Principles of the Subject; Chief Thermal Phenomena of the Electrolytic Separation of Metals; Chief Chemical Facts and Principles of the Subject; Chief Facts of Chemico-Electric or Voltaic Action; Chief Facts of Electro-Chemical Action; the Generation of Electric Currents by Dynamo-Machines.

Practical Division.—Establishing and Working an Electrolytic Refinery; Other Applications of Electrolysis in Separating and Refining Metals, &c.

Cloth, 4s. 6d., Post Free. 55 Illustrations. By JAMES SWINBURNE.

PRACTICAL ELECTRICAL MEASUREMENT.

"Altogether the book is an excellent one, the few points that have been objected to in this notice being almost the only ones that out of a large mass of matter have struck us as perhaps open to criticism."—*Electrician*, February 15th, 1889.

"The author comes to his task, however, so well equipped by practical experience, that there appears to be a basis for his very pronounced confidence. His selection and treatment of the subject matter is decidedly original, and a large amount of stereotyped matter, which is usually deemed indispensable to works on electrical subjects, is conspicuous by its absence."—*The Electrical Engineer* (New York), February, 1889.

"Taken as a whole, the book is a most readable and instructive one, and, with the illustrations, is a valuable addition to the literature of a subject which is interesting to all engaged in practical electrical work."—*Electrical World*, New York, January 12th, 1889.

"It does not need commending; we have only to give the author's name and that of the publishers."—*Electrical Plant*, January, 1889.

Leather, 5s., Post Free. By H. R. KEMPE, M.Inst.E.E. A.M.Inst.C.E.

THE ELECTRICAL ENGINEER'S POCKETBOOK

OF MODERN RULES, FORMULÆ, TABLES AND DATA.

Cloth, 4s. 6d., Post Free. 41 Illustrations and 5 Tables. By F. B. BADT.

INCANDESCENT WIRING HANDBOOK.

Multiple Arc System; Three-Wire System; Methods of Running Wire; Location of Safety Devices and Switches; Fixtures and Elevators; Wire Gauges; General Electrical Data; Calculating Sizes of Wires; and two Appendices.

Cloth 4s. 6d., Post Free. 70 Illustrations. By F. B. BADT.

DYNAMO TENDERS' HANDBOOK.

Elementary Data; Arrangement of Power; Dynamo-Electric Machines; Diseases of Dynamos; Lamps; Instruments; Circuits or Leads; Accumulators; Safety Regulations; Table of Electric Light Conductors; Lamp Lighting Schedule; Construction Tools.

Cloth, 4s. 6d., Post Free. 97 Illustrations. By F. B. BADT.

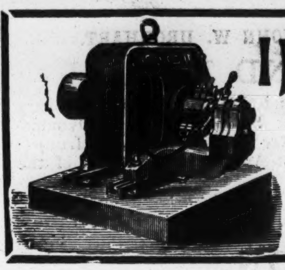
BELL HANGERS' HANDBOOK.

Voltaic Electricity; Description of Batteries; Elementary Data; Connecting Batteries; Battery Data; Electro-Magnets; Induction Coils; Electric Bells; Annunciators; Electric Alarms; Gas Lighting Apparatus; Electric Heat Regulation; Running Electric Wires; Testing Instruments.

Any of the above Books can be had Carriage Paid by sending a remittance for the price indicated to

H. ALABASTER, GATEHOUSE & CO., 22, PATERNOSTER ROW, LONDON.

EWEN & Co.'S STEAM BOILERS
LOCO, MULTITUBULAR,
LANCASHIRE and other types,
Constructed for High-Pressure Steaming.
FITTED WITH APPARATUS ELIMINATING ALL DEPOSIT ON BOILER PLATES. GUARANTEED.
ILLUSTRATED PRICE LIST UPON APPLICATION.
ENGINEERS & BOILER MAKERS,
WALBROOK HOUSE, LONDON, E.C.
Works: St. GEORGE STREET, LONDON, E.
London Office of CHARLESWORTH, HALL & CO., *See Advertisement Page Sup. 19.*
3834



INCANDESCENT ✱ LAMPS
EVERY NECESSARY FOR ELECTRIC LIGHTING.
DYNAMOS OF THE BEST CONSTRUCTION.
MEASURING INSTRUMENTS AT LOWEST PRICES 3811
F. ZÖPKE, Wilhelm-Strasse, 98, BERLIN, W.

THE OLDEST ESTABLISHED WEEKLY ELECTRICAL PAPER.

ESTABLISHED 1872.

THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY

OFFICE, 22, PATERNOSTER ROW, LONDON.

TELEGRAPHIC ADDRESS: "AGEEKAY, LONDON." CODE A B C.

All Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

SUBSCRIPTION RATES.—In Great Britain, post free, per year, 19s. 6d. To all Foreign Countries (except those mentioned below), per Year, £1 1s. 8d. Exceptions.—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Philippine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 3s. 10d.

VOLUME XXVI. can now be had bound in black cloth, gilt, at 12s.

BINDING.—Subscribers' numbers bound for 3s. 6d. each volume, including case. **CASES.**—Cloth Cases for Binding can be had. price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers, till the Volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain) 6s. 6d.

FOREIGN AGENTS.—New York: D. Van Nostrand, 23, Murray Street. Paris: Veuve J. Boyveau, 22, Rue de la Banque Berlin: Asher & Co., 5, Unter den Linden.

NOTICE TO ADVERTISERS.

The following are the latest times up to which Advertisements can be received for publication in current week's issue:—

New Advertisements, or Alterations to existing ones, Wednesday 2 p.m.
Small Announcements for middle pages Thursday 2 p.m.

ADVERTISEMENT RATES ON APPLICATION.

Cheques and Post Office Orders (on Chief Office, London) to be made payable to Mr. H. Alabaster, 22, Paternoster Row, E.C.

No 0302.

POOLE & WHITE,

LIMITED,

No. 0307.

58 and 59, CHEAPSIDE,

No. 3100.

Bread Street, LONDON, E.C.

THE POOLITE SWITCH

For Current Capacities up to 3 Amperes.

No. 0342.

PLATESSA PATENT CEILING ROSE.

No. 0335.

MANUFACTURERS AND SUPPLIERS TO THE

TRADE ONLY.

TELEPHONE No. 1,982.

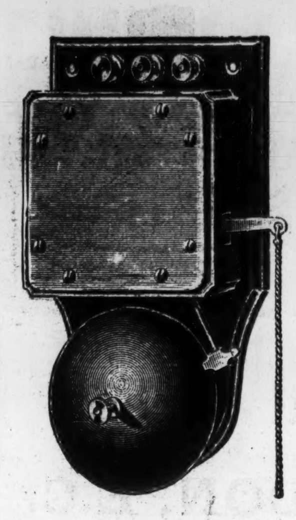
No. 0314.

Telegraphic Address: "PLATESSA," LONDON.

No. 0313.

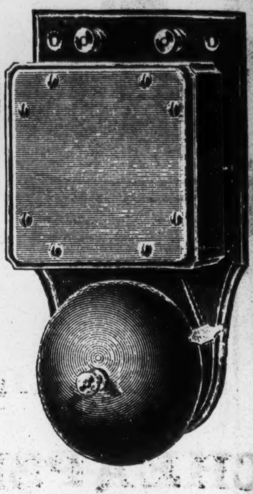
ALL ARTICLES
ARE MANUFACTURED SOLELY BY US
AT OUR WORKS
AT THE ABOVE ADDRESS.

No. 0335.



BELLS OF EVERY

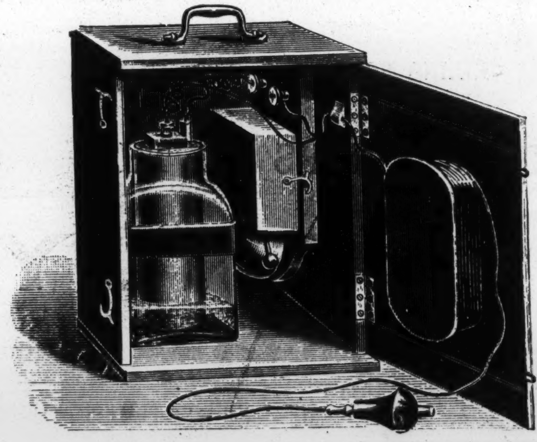
DESCRIPTION

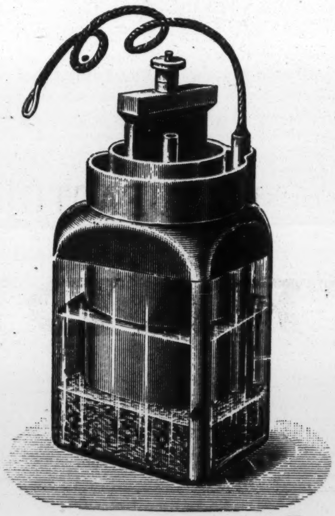


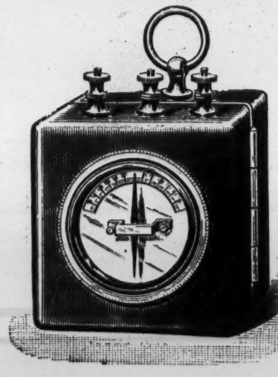
APPLETON, BURBEY
AND
WILLIAMSON.

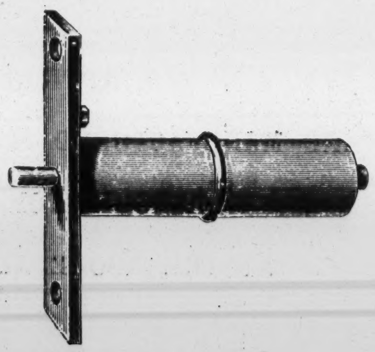
BALMORAL BUILDINGS, 91, QUEEN VICTORIA ST.
STEAM WORKS, HATTON GARDEN.

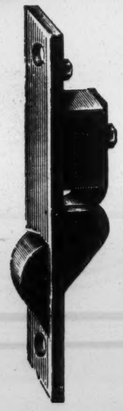
ELECTRICAL MANUFACTURERS.











WILLANS CENTRAL VALVE ENGINES

(PATENTS OF 1884 AND 1885),

Are made in Ten Standard Sizes, from 3 to 530 I.H.P., with either One or Two Cranks, and for Speeds of from 280 to 700 Revolutions.

They are equally suited for **Condensing** or **Non-Condensing;** for the direct driving of **High-Speed Machines,** such as **Dynamos** and **Fans,** or for **Driving General Machinery** by Belts or Gearing. It is now fully established that they possess **Extraordinary Freedom from Wear,** as **all** Bearings are in "constant thrust" (which is not the case with many Single-Acting Engines), and are Self-Lubricated. Their **Small Size and Weight,** while advantageous in all cases, fit them for uses to which the majority of engines are inapplicable. Al except the smallest sizes are made either **Simple, Compound,** or **Triple-Expansion,** according to the pressure available, and recent trials show that they work with a

SMALLER CONSUMPTION OF STEAM

Than **any** other type of engine in the market indicating equal power. Non-Condensing, a consumption of steam as low as 18·2 lbs. per I.H.P. per hour has been recorded, and the Makers are prepared to **Guarantee** that the larger Condensing Engines shall work, at least, as economically as the best class of Compound Corliss Engines, while possessing enormous advantages in **Lightness, Compactness** and **Cheapness.**

THE WILLANS CENTRAL-VALVE ENGINE IS WITHOUT RIVAL

FOR ELECTRIC LIGHTING,

For which purpose several hundreds have already been applied with the utmost success. Engines are on order at the present time for nearly all the most important Public Lighting Stations now under construction in England, and the indicated power of the Engines already supplied, or now on order, exceeds

Thirty-Thousand Horse-Power.

PRICE LISTS WITH FULL PARTICULARS ON APPLICATION.

WILLANS & ROBINSON, LTD., ENGINEERS,

THAMES DITTON, SURREY. 3015

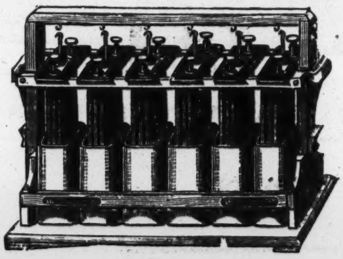
J. ORME & CO.,

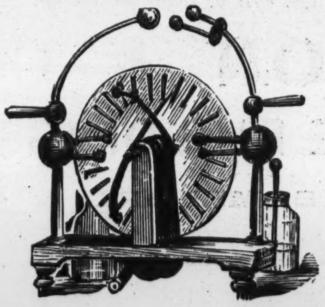
MANUFACTURERS OF EVERY DESCRIPTION OF

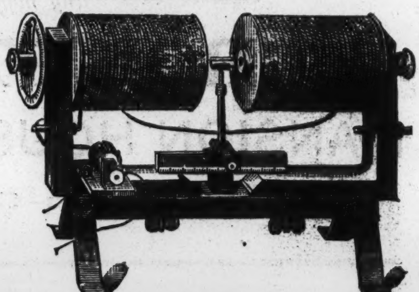
APPARATUS FOR USE IN TEACHING OR EXPERIMENTING IN THE SCIENCES OF CHEMISTRY, ELECTRICITY, MAGNETISM ACOUSTICS, LIGHT, HEAT, HYDROSTATICS, MECHANICS, &c.

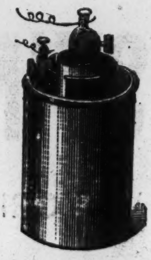
IMPORTERS OF FINEST BOHEMIAN GLASS, BERLIN PORCELAIN, PURE CHEMICALS FOR ANALYSIS &c.

ELECTRIC BELLS AND BATTERIES.









Apparatus for Science Classes supplied through the Science and Art Department at 50 per cent. reduction of prices.

ILLUSTRATED PRICE LIST OF ELECTRICAL APPARATUS, POST FREE, THREE STAMPS.

Price List of Chemical Apparatus with 650 Illustrations, post free eight stamps.

TRADE TERMS AND SPECIAL QUOTATIONS FOR EXPORT SENT ON APPLICATION. 205

J. ORME & Co. (Late M. Jackson & Co.), 65, Barbican, London, E.C.

WESTERN ELECTRIC CO.

TELEPHONIC APPARATUS.

ARC LAMPS AND DYNAMOS.

PATTERSON CABLES FOR TELEPHONES, TELEGRAPHS AND ELECTRIC LIGHT.

79, COLEMAN STREET, LONDON, E.C.
CHICAGO, NEW YORK AND ANTWERP.

1906

CENTRAL STATIONS.

CROMPTON & COMPANY, LIMITED, have erected, or are now erecting, Central Stations, and manufacturing machinery for same, to supply

321,000 LAMPS.

This represents two-thirds of the total horse-power being put down in this Country for Continuous Electric Supply, or in other words,

100,000 LAMPS

MORE THAN ALL OTHER LOW PRESSURE SYSTEMS COMBINED.

Full information on the latest developments of Electrical Engineering and Tenders for Central Stations of any magnitude, can be obtained by applying to—

CROMPTON & CO., Ltd.,
MANSION HOUSE BUILDINGS, LONDON, E.C.
Works:—CHELMSFORD & LONDON.

311

THE
WESTINGHOUSE ELECTRIC Co.,
LIMITED,
4, VICTORIA MANSIONS, 32, VICTORIA STREET, S.W.

MANUFACTURERS OF
ELECTRIC LIGHTING APPARATUS
FOR
CENTRAL STATIONS & ISOLATED PLANTS.

ESTIMATES ON APPLICATION.

3265